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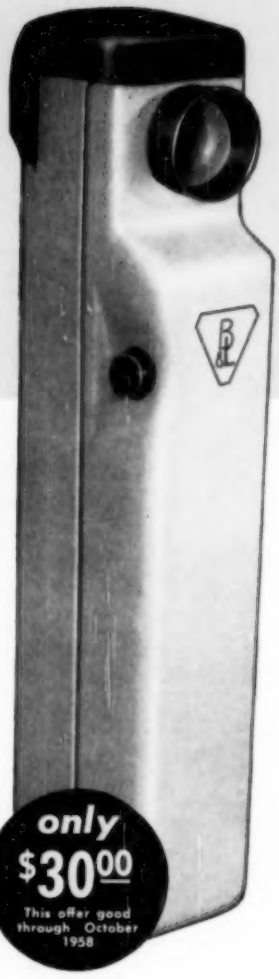

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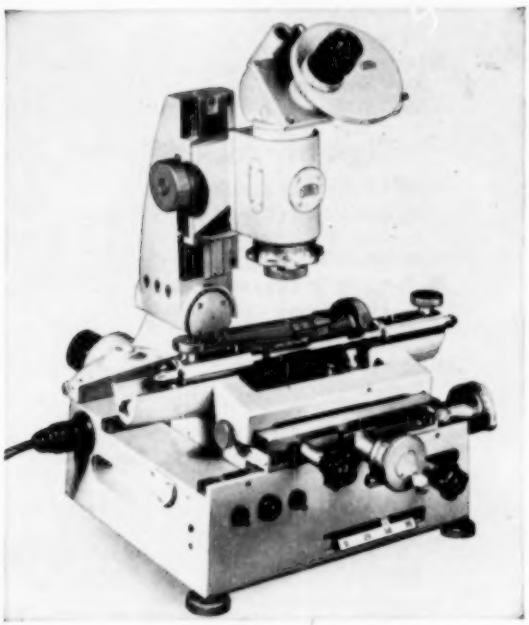

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Determining the "Best Possible" Inventory Levels*

KALMAN JOSEPH COHEN

Introduction

We shall be concerned here with the problem of how inventory levels should be established. This is an important problem, for inventories play a role in all phases of business and industry, whether retail, wholesale, or manufacturing. Rather than considering all aspects of inventory problems, however, we shall concentrate on the function of inventories in the distribution of commodities, in particular, in the wholesaling operations, and we shall not be concerned with the part that inventories play in manufacturing.

In a distributional business, the reason for having any inventory is to sell goods. Usually, you cannot sell anything to a customer unless you have it in stock. These considerations would tend to make wholesalers or retailers carry large inventories, for the more items there are in stock, the greater are the chances of having what customers want when they want it.

However, there are limits to the size of the inventories which any business would want to have, these limits arising because it costs money to hold inventory. Inventories can be considered to be too large when the costs of carrying the commodities exceed the benefits obtained from having them in stock. On the other hand, inventories are insufficient when the additional gains from having more inventory are greater than the additional costs which would be generated. Somewhere in between there exists the *best possible* level of inventory, i.e., that level of inventory which results in the largest possible profit for the business. How to find the level of inventory which is best is the subject of this article.

The Warehouse Network

The particular work which we shall discuss was done for the Replacement Division of Thompson Products. This Division does no manufacturing, so we need not consider the functions of inventories in manufacturing operations. Replacement Division is a large distributor of automotive engine and chassis parts for replacement use, as is indicated in Fig. 1. This Division buys these parts in bulk from various manufacturers and sells them to wholesalers or jobbers, who in turn sell them to independent garagemen, car dealers, and fleet operators.

Replacement Division has one central warehouse in Cleveland and 36 branch warehouses scattered throughout the United States. Most of the sales are made at the branches. The central warehouse serves mainly as a supply depot, from which all branch stocks are sent.

The inventory problem at the branch warehouses consists in determining the best possible amounts of inventory which should be carried in stock. The magnitude of this problem can be appreciated from the fact that approximately 15,000 items are sold at each of the 36 branches, so there are more than half a million branch warehouse inventory levels to be established.

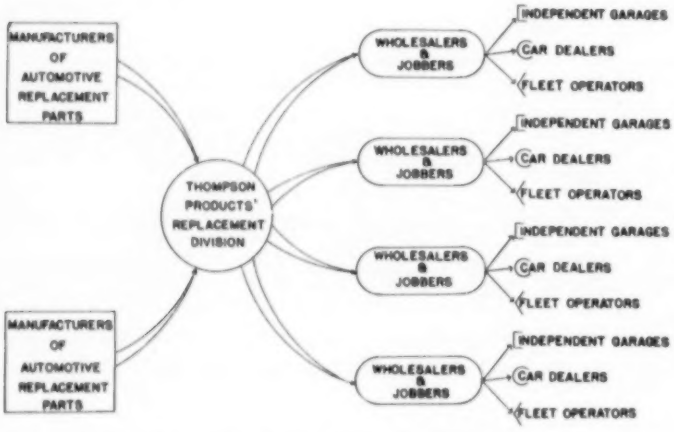

Figure 1—Physical Flow of Replacement Parts

Sales Demand at the Branches

If it were possible to say exactly how many parts would be sold each week at every branch and how long it would take to get these parts to the branches from the central warehouse, then it would be relatively easy to specify the best possible inventory levels at each branch warehouse. The problem that we have to deal with is considerably more difficult, however, because of two unavoidable elements of uncertainty: uncertainty about the sales demand at the branches and uncertainty about the time required to send parts from the central to the branch warehouses.

The uncertainty in the sales demand for an item which occurs at the branches is illustrated in Fig. 2, where we see a typical pattern in the fluctuations of weekly demand. It looks as though we could say with some degree of assurance that the sales demand for that part at the branch will average ten units per week, but what it will be in any particular week, we cannot say. Some orderliness can be derived from this chaos, however, if we ask, not what the demand will be in any particular week, but how frequently we can expect weekly demands of different amounts.

*Presented at the Fourth Annual Cleveland Quality Control Conference, American Society for Quality Control, November 5, 1957, Cleveland, Ohio. This article was written while the author was a Member of the Technical Staff, Management Sciences Department, The Ramo-Wooldridge Corporation. He is now a member of the faculty of the Graduate School of Industrial Administration, Carnegie Institute of Technology.

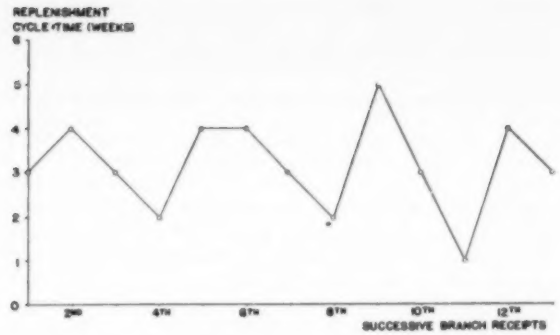

Figure 2—Variations of Demand for an Item at a Branch

If we look at the weekly demands for a part at a branch over a large enough number of weeks, there will become evident a stable pattern of the relative frequencies with which different levels of demand occur. Over a long enough period of time, the pattern of weekly demand that we saw in Fig. 2 will build up into the frequency distribution of weekly demand shown in Fig. 3. Here we see that the most frequently occuring weekly demand is the average demand of ten units per week, the next most frequently occurring demand is nine units per week, and so forth. Furthermore, a weekly demand of ten units occurs three times as frequently as a weekly demand of five units, etc.

Statisticians apply the name "Poisson distribution" to describe the type of frequency distribution shown in Fig. 3. For our purposes, we need know only that the shape of the Poisson distribution is completely determined by its average value, and that we can use this distribution to describe the uncertainties in the weekly demand for a part at a branch warehouse.

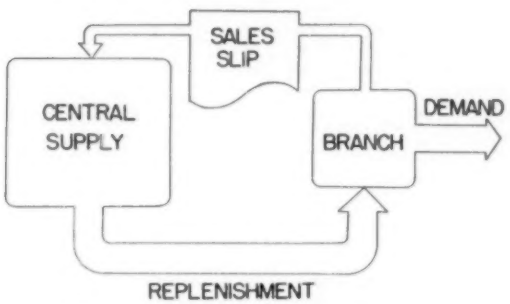

Figure 4—Branch Warehouse Supply System

Because of the fluctuations in sales demand, it sometimes happens that a branch is out of stock on an item when a customer wants it. This results in a *lost sale*, for when a customer cannot immediately obtain a particular part from the local branch warehouse, he will usually purchase it from a competitor. Thus, lost sales are lost business, and if a branch is out of stock when an item is requested, Replacement Division foregoes the profit that could have been made by selling that item.

The Replacement System

The branch warehouses are not autonomous in their operations. The central warehouse maintains rigid inventory control over the branches, determining what their inventory levels should be and actually shipping all stocks for the branches from Cleveland. The relation between the central and branch warehouses is shown schematically in Fig. 4. Whenever a part is sold at a branch, a copy of the sales slip is immediately sent to Cleveland, so that the central warehouse can prepare an invoice for the customer. Cleveland accumulates the sales slips from a branch for a whole week, and it then prepares a replenishment shipment to restore the branch warehouse's inventory, replacing each part which has been sold during the week on a one-for-one basis. Thus, sales of all parts for a week are automatically replaced on a weekly basis, and a replenishment shipment is sent each week to every branch warehouse.

Replenishment Cycle Time

The period between the first sales slip for a week being sent from a branch to Cleveland and the receipt of the corresponding replenishment shipment at the branch can be called the *replenishment* cycle. Another major element of uncertainty in the system is the length

Figure 3—Frequency Distribution of Weekly Demand for an Item at a Branch

of the replenishment cycle, for this varies from week to week. Fig. 5 shows a typical pattern in the fluctuations of replenishment cycle times. While the average replenishment cycle time shown here seems to be three weeks, there are substantial variations from one week to another. We can deal with the uncertainty of the replenishment cycle time as we dealt with the uncertainty in weekly sales demand. That is, we shall ask not what the replenishment cycle time will be in any particular week, but how frequently we can expect replenishment cycles of different lengths.

If we look at the replenishment cycle time over a large enough number of weeks, there will become evident a stable pattern of the relative frequencies with which different lengths of replenishment cycles occur. Over a sufficiently long period of time, the pattern of replenishment cycle times that we saw in Fig. 5 will build up into the frequency distribution of replenishment cycle times shown in Fig. 6. Here, we see that the most frequent replenishment cycle time is three weeks, which occurs

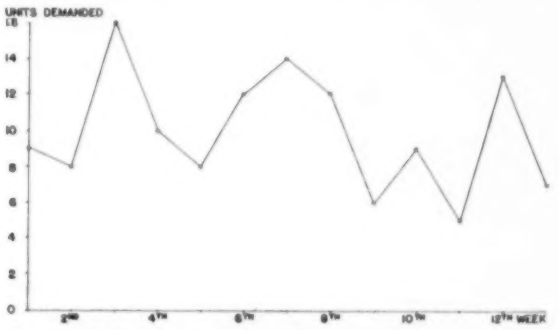

Figure 5—Variation of Replenishment Cycle Time for a Branch

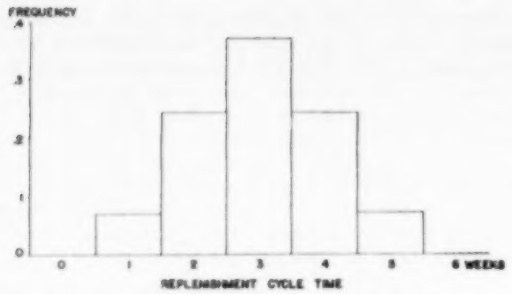

Figure 6—Discrete Frequency Distribution of Replenishment Cycle Times

about 38 percent of the time. Replenishment cycles of two or four weeks each occur about 24 percent of the time, and replenishment cycles of one or five weeks each occur about 7 percent of the time.

Statisticians apply the name "normal distribution" to the type of frequency distribution shown in Fig. 6. For our purposes, we need know only that the shape of the normal distribution is completely determined by its average value and its standard deviation, and that we can use this distribution to describe the uncertainties in the replenishment cycle time at a branch warehouse.

The uncertainties in replenishment cycles are actually somewhat more complicated than those indicated by the distribution shown in Fig. 6. How long the replenishment cycle will be in one week seems to depend on how long it was in the previous week, since there is a positive correlation in the lengths of successive replenishment cycles. Although over a long period of time, the relative frequencies with which different replenishment cycles occur is adequately described by the normal distribution, the positive correlation between successive replenishment cycle times means that the magnitude of the weekly fluctuations will be lessened. Figure 7 illustrates the difference in replenishment cycle patterns which occurs depending on whether this correlation is present or absent. The "correlated" time series shown in Fig. 7 is much more sluggish than the "independent" time series. Without going into complicated mathematical details, we can say only that the positive correlation between successive replenishment cycles can be superimposed on the distribution of replenishment cycle times, the result being that statisticians would describe the uncertainties in replenishment cycle time as a serially correlated, normally distributed random variable.* (Since we have momentarily lapsed into statistical jargon, we can mention in passing that statisticians would similarly describe the uncertainties in weekly sales demand as a Poisson distributed random variable.)

* A method for handling the serial correlation in replenishment cycles has been developed in Jack Weinstock and David Young, "The Influence of Correlation of Replenishment Times on Inventory Control Systems," Operations Research Society of America, Tenth National Meeting, November 15-16, 1956, San Francisco, Calif. Figure 7 was taken from the Weinstock and Young paper.

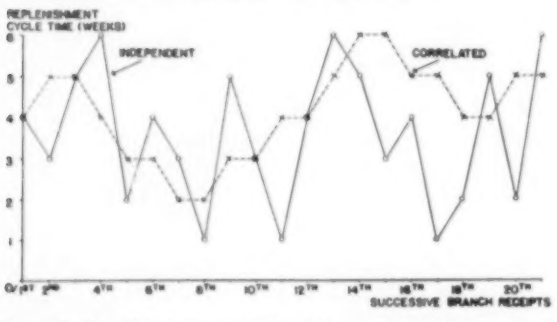

Figure 7—The Effect of Serial Correlation on Replenishment Cycle Times

The Relation Between Lost Sales and Inventory Levels

Let us once again look at the schematic relation between the central and branch warehouses. This is illustrated in Fig. 8, where we have introduced roulette wheels to indicate the uncertainties in weekly sales demand and replenishment cycle time. These two elements of uncertainty make it impossible for a branch always to have parts in stock when customers want them. The frequency with which a branch is out of stock on items that customers want depends upon the size of that branch's inventories, for the branch warehouse inventories function as buffers which mediate the uncertainties of sales demand and replenishment cycle time. Therefore, a necessary step in determining the best possible levels for branch inventories is first to determine the relation between lost sales of an item and the level of inventory for that part at a branch.*

If sufficient historical data were available, it would be possible to determine directly how lost sales depend upon inventory levels. The required data were not available, however, so it was necessary to adopt an alternative approach. Essentially, what we did was to reconstruct or simulate the history of branch warehouse operations on a high-speed electric computer.† From this reconstructed history, we were able to obtain the required data, and thus, the dependence of lost sales on inventory levels.

Technically, this simulation of history on a computer is called a "Monte Carlo" approach, after the gambling casino of the same name. Anybody who has watched the roulette wheels at Monte Carlo or Las Vegas can understand the reasoning behind this approach.

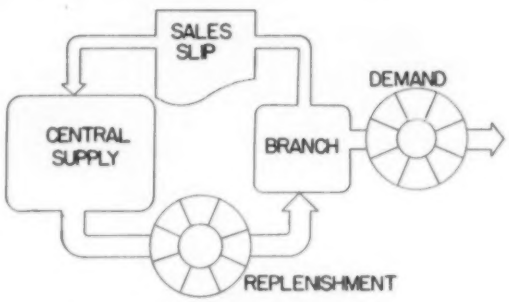

Figure 8—Branch Warehouse Supply System

Let us look again at Fig. 8, which shows the relation between the central and branch warehouses. With the one-for-one replenishment system which is being

* An analytical method for determining the relation between average lost sales and inventory level for the special case in which successive replenishment cycle times are uncorrelated has been developed in William Karush, "A Queuing Model for an Inventory Problem," *Operations Research*, Vol. 5, No. 5 (Oct. 1957), p. 693-703, and in Philip M. Morse, *Queues, Inventories and Maintenance*, New York: John Wiley and Sons, Inc., 1958, p. 139-146.

† This Monte Carlo approach has been discussed in: (a) Kenneth C. Lucas and Leland A. Moody, "Electronic Computer Simulation of Inventory Control," p. 107-121 in *Electronics in Action: The Current Practicality of EDP*, Special Report No. 22, American Management Association, New York, 1957. Figures 2, 4, 5, 8, and 9 were taken from the Lucas and Moody paper; (b) Jack K. Weinstock, "An Inventory Control Solution by Simulation," p. 65-71 in *Report of System Simulation Symposium*, (Sponsored by the American Institute of Industrial Engineers, The Institute of Management Sciences, and the Operations Research Society of America, held in conjunction with the 8th National Convention of the American Institute of Industrial Engineers, New York, May 16, 17, 1957), 1958; (c) Andrew Vazsonyi, "Electronic Simulation of Business Operations (The Monte Carlo Method)," Second Annual West Coast Engineering Management Conference, May 27-28, 1957, Los Angeles, California, sponsored by the Management Division, Southern California Section, The American Society of Mechanical Engineers.

used, the number of sales during any week of a part at a branch (and the number of lost sales) depends only upon the sales demand during that week and the inventory on hand at the start of the week. This starting inventory depends, in turn, upon sales during previous weeks, the lengths of time required for replenishment cycles during preceding weeks, and the level of inventory which was initially established.

Thus, in order to determine the actual sales and lost sales which can be expected to result from a given initial inventory level, it is necessary to know only the patterns of sales demand and replenishment cycle times which occur. Both demand and replenishment times are uncertain, but typical patterns for them can be constructed from the frequency distributions which describe them. Conceptually, we can think of generating these patterns by each week spinning the two roulette wheels shown in Fig. 8. Since actually doing this would require too much of our own time, we let the electronic computer calculate the values which result from spinning the

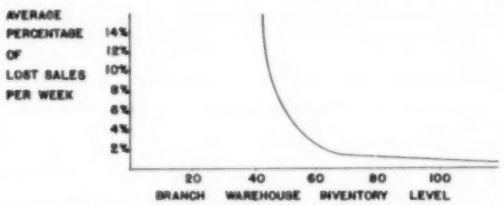

Figure 9—Expected Weekly Lost Sales as a Function of Branch Inventory Level, for Average Demand of Ten per Week

roulette wheels. A high-speed computer can run through calculations of this type very, very quickly, and in a brief time it is possible to determine the average number of lost sales which will occur each week for any particular initial inventory level.

Using the computer to simulate history resulted in a set of curves similar to the one shown in Fig. 9. For a given average weekly sales demand, the percentage of sales which will be lost decreases as the inventory level increases. However, as we see in Fig. 10, the exact relation between the average percentage of lost sales per week and branch inventory level depends upon the average weekly demand.

The SOBIL (Simulated Optimal Branch Inventory Levels) System

Once we know the relation between average lost sales and inventory levels, we are ready to use this knowledge to establish the best possible branch warehouse inventory levels. By "best possible" inventory levels, we mean those levels of inventory which will result in the largest total expected profits from the operations of the branches. By balancing the expected gain resulting from the sales that branch warehouse inventories will support against the expected cost of carrying this inventory, normal inventory levels can be established for every part at each branch in a way which leads to the largest possible total profits. For convenience, we have invented the name "SOBIL System" to refer to the use of the simulation curves of Fig. 10 for establishing branch warehouse inventory levels which are optimal in accordance with the expected profit maximization criterion.

The gross gain each week from holding inventory is the product of the average weekly sales that will result from this inventory and the gross margin per unit

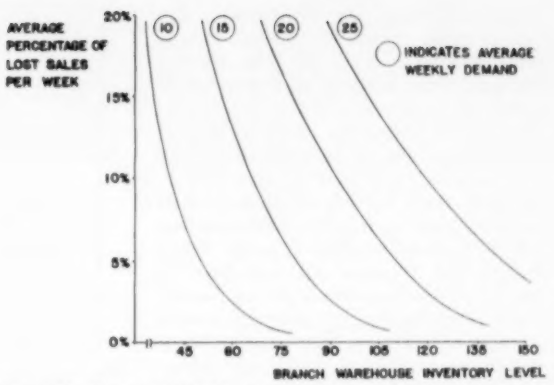

Figure 10—Expected Weekly Lost Sales as a Function of Branch Inventory Level, for Various Average Weekly Demands

sold, where the gross margin on a part is the difference between its selling price and material cost. The reasonableness of this can be seen from the following three considerations.

First, lost sales, as measured by the simulation curves of Fig. 10, are lost business. This is substantially true, for customers are usually unwilling to wait for a part when a branch is out-of-stock. Of course, for very minor delays of a day or two pending receipt of a shipment already in transit, some customers may be willing to wait, but this possibility has in fact already been taken into account by the manner in which the simulation curves were derived.

Second, in those rare instances when a customer who requests a part from a branch which is out of stock is willing to experience a substantial delay in obtaining it, i.e., to allow his order to be back-logged, there are considerable extra costs incurred in processing, expediting, handling, and shipping this order. These extra costs probably eliminate profit which would have accompanied a normal sale of the item.

Third, the administrative and processing costs of handling customer orders are the same regardless of whether those customer orders result in direct sales or lost sales.

On the opposite side of the ledger, the penalty attached to holding inventory is the cost of carrying this inventory. Specifically, we must consider those variable elements of inventory carrying costs which depend upon the size of inventories actually held, as e.g., the cost of invested capital, obsolescence, insurance and taxes, handling and labor costs, and space costs. In Replacement Division, the variable costs of holding inventory at a branch warehouse are proportional to the value of that inventory, where inventory is valued at material cost per unit times the number of units.

We can define the *net gain* from holding inventory to be the gross gain resulting from this inventory less the variable costs of holding this inventory. In terms of our analysis, the weekly net gain from an inventory of a part at a branch is simply the expected weekly sales of the part that this inventory level will support times the gross margin per unit, less the weekly variable cost of carrying this inventory. The optimal inventory level for a part at a branch, as defined by the SOBIL System, is the amount of inventory which will maximize the weekly net gain. If all branch warehouse inventory levels were established according to the SOBIL System, then the overall expected profits of the operation will be maximized.

The procedure for establishing the best possible inventory levels is shown symbolically in Fig. 11. The weekly net gain from holding an inventory of a part at a branch is a function of the size of that inventory. In order to find the optimal size of that inventory, we can set the derivative of the weekly net gain from holding inventory equal to zero, and then solve this equation for the optimal inventory level. When we do this, it turns out that the best possible inventory levels do not depend upon the height of the simulation curves of Fig. 10, but, rather, they depend upon the *slopes* of these curves. In particular, in order to establish the optimal inventory levels, we have to know the relation between the rate of increase in average weekly sales and branch warehouse inventory levels. The form of this relation is shown in Fig. 12, where we see that for any given level of average weekly demand, the rate of increase in average weekly sales decreases as the inventory level increases. The electronic computer can be used to produce these new curves shown in Fig. 12, as well as the simulation curves shown in Fig. 10.

D = average weekly demand for an item at a branch warehouse
X = branch warehouse inventory level for the item
$l(X)$ = average weekly lost sales for the item at the branch, as a percentage of the demand
P = selling price of the item
C = material cost of the item
v = weekly variable inventory carrying costs, as a percentage of branch warehouse inventory value
$G(X)$ = weekly net gain from a branch warehouse inventory level of X for the item

Criterion: the optimal branch warehouse inventory level for the item is that X that maximizes $G(X)$. This value of X must satisfy the inequality

$$G(X-1) < G(X) > G(X+1),$$

where

$$G(X) = (P-C)[1-l(X)]D - vCX.$$

The inequality is equivalent to

$$(P-C)Dl(X-1) - vC > (P-C)Dl(X) < (P-C)Dl(X+1) + vC.$$

The value of X that satisfies this inequality can be closely approximated by solving the equation obtained by setting the derivative of $G(X)$ with respect to X equal to zero. This leads to

$$-\frac{dl(X)}{dX} = \frac{vC}{(P-C)D}.$$

This means that the solution is equal (or very nearly equal) to the value of X where the negative slope of the $l(X)$ curve is equal to $vC \div (P-C)D$.

Figure 11—The SOBIL System

To determine the optimal inventory level for a part at a branch, we first select the curve from Fig. 12 which corresponds to the average weekly sales demand for the item. Suppose that this particular curve is the one shown in Fig. 13. Next, we divide the variable cost of carrying one unit of inventory for a week by the gross margin on the part. The resulting value, as we see in Fig. 13, is found on the vertical axis. From there, we move horizontally from the curve, and then we move vertically from the curve to the horizontal axis. The level of inventory which is then indicated on the horizontal axis is the best possible inventory level for the part at the branch.

If desired, rather than using this graphical procedure, the determination of optimal branch inventory levels can readily be programmed for an electronic computer.

It must be emphasized that while the SOBIL System provides an automatic way of determining branch warehouse inventory levels, this neither restricts management's prerogative nor eliminates the need for sound business judgment. Management always has the discretion to establish branch warehouse inventory levels other than those indicated by the SOBIL System, if policy considerations should so dictate. Indeed, management might want to do so because of a desire to give exceptional service to favored customers, to maintain a particular share-of-the-market, or aggressively to develop a new market. In such cases it is easy to determine the net gain from holding inventory *which is foregone* by establishing a branch warehouse inventory at some level other than that indicated by the SOBIL System. This provides additional information which management would not otherwise have, information which can help management decide whether the special policy considerations are worthwhile. Figure 14 shows the form in which this information could easily be provided if the calculations of optimal branch warehouse inventory levels are done on an electronic computer.

Forecasting Requirements for the SOBIL System

In order to make effective use of the SOBIL System, it is necessary to forecast the average weekly demand for every item at each branch. This may not be easy to do, for these average weekly demands slowly change over time.

Over a long period, the local demand for an automotive replacement part will vary because of the changing size and age distribution of the existing stock of automobiles and trucks, the changing number of models in which the part has been used, competition, seasonal factors, and random fluctuations.

Many alternative methods for forecasting demand by item by branch should be investigated. Perhaps the simplest procedure is to use a moving average or linear trend extrapolation based on recently experienced demand. More sophisticated would be the use of a life cycle growth and decay curve based on the number of models in which a part has been used and the elapsed times since the part was first and last incorporated in a new model.

Even more elaborate would be a mortality, age-distribution, share-of-the-market model. The size of the market for a replacement part would be estimated by considering the size and age distribution of the existing stock of automobiles and trucks, the probability of the part becoming defective as a function of the age of the

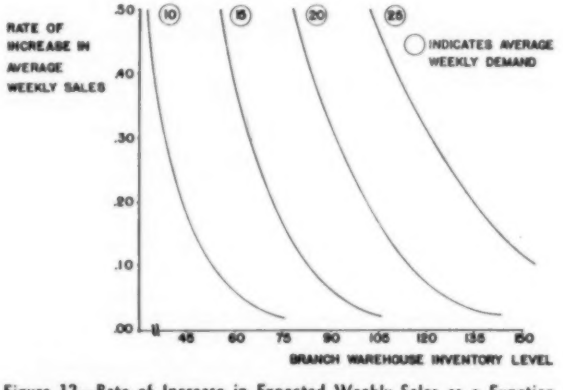

Figure 12—Rate of Increase in Expected Weekly Sales as a Function of Branch Inventory Level, for Various Average Weekly Demands

machine in which it is housed, and the models in which the part has been incorporated. The size of the market for the part is then multiplied by each branch warehouse's assumed share-of-the-market to yield the forecasts of the average demand for that part at the various branch warehouses.

Any or all of these forecasting procedures might be improved by making adjustments for seasonal variation.

How often the forecasts of average weekly demand should be revised depends upon how frequently the branch warehouse inventory levels should be changed. This, in turn, depends upon the clerical and data-processing costs required to reset the branch inventories, the net gain from holding inventories which is foregone because of using incorrect estimates of average weekly demand, and any changes which might occur in the values of critical parameters, such as the means or variances of the replenishment cycle times, the cost of capital, or other inventory holding costs.

Testing the SOBIL System

Before completely accepting the worthwhileness of the SOBIL System, it is desirable to estimate the magnitude of the increased profits which should result from the use of this procedure. There are two general ways of making such an estimate, either through a careful analysis of historical data or through a program of controlled experimentation.

The cheapest and fastest way of estimating the amount of increased profits which should result from adopting the SOBIL System is to assume that the equation defining the net gain from holding inventories and the simulation curves expressing the dependence of average lost sales on branch warehouse inventory levels are all accurate. On this basis, it is possible to compare the net gain from holding inventories which was actually experienced with the net gain from holding inventories which would have occurred had the branch warehouse inventories been established at the levels indicated by the SOBIL System.

Using historical data on actual sales, lost sales, and branch warehouse inventory levels, it is possible to compute what the net gain from holding inventories actually was during some past period. This can be done for a randomly selected sample of items and branches, or, if time and budget permit, for all items and branches.

From the same historical data on actual demand, it is possible to determine the potential performance of the system, i.e., the net gain from holding inventories which would have resulted from optimal inventory levels. The results of these two calculations should then be compared. The difference between the net gain from holding inventories had optimal branch warehouse inventory levels been established and the actually experienced net gain indicates the increased profits which should result from using the SOBIL System.

The conclusive test of the SOBIL System can come only from a controlled experiment, however. Using proper experimental design principles, a randomized sample of branch warehouses should have their inventory levels established as indicated by the SOBIL System. In the remaining branches, the inventory levels should continue to be determined by the present system. The worthwhileness of the SOBIL System can then be determined by comparing the profitability of those branches where it was employed with the remaining branches. In order to get a meaningful basis of comparison which is independent of size, what should be considered is the percentage change in profits of the branch warehouses, not the absolute profits themselves. Then, the measure

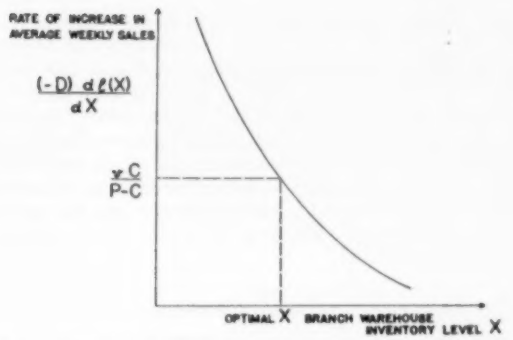

Figure 13—SOBIL System, Graphical Determination of Optimal Branch Inventory Levels

of effectiveness of the SOBIL System would be the ratio of the percentage change in profits of those branches using this new system to the percentage change in profits of those branches using the present method.

Conclusion

In this article we have described a procedure, which we have called the SOBIL System, for establishing the best possible branch inventory levels in a network composed of one central and several branch warehouses using a one-for-one replenishment system. Since the branch warehouse inventories function as buffers mediating the uncertainties of weekly sales demand and replenishment cycle time, there is a probabilistic dependence of weekly lost sales on branch inventory levels. A Monte Carlo approach, that is, a simulation of the history of the system on an electronic computer, was used to determine the relation between average weekly lost sales and inventory levels. By balancing the expected gain resulting from the average weekly sales that branch warehouse inventories will support against the expected cost of carrying inventories, our knowledge of the relation between average weekly lost sales and inventory levels can be used to determine optimal branch warehouse inventories, i.e., the levels of inventory which yield the longest possible net gains from holding inventory.

In addition to outlining the conceptual framework of the SOBIL System, we have indicated graphical and computational techniques which could be used in implementing the procedure, discussed the nature of the forecasts which must be made, and presented ways of determining the amount of increased profits which should result from adopting this system.

In a warehouse network such as we have described, adoption of the SOBIL System should result in several advantages. First and foremost, the total profits of the business should be increased, because of the optimal

PART P BRANCH WAREHOUSE B AVERAGE WEEKLY DEMAND 10

BRANCH WAREHOUSE INVENTORY LEVEL	AVERAGE PERCENTAGE OF LOST SALES	NET GAIN FROM HOLDING INVENTORY	FOREGONE NET GAIN FROM HOLDING INVENTORY
40	200	640	1.10
45	1.15	7.05	.45
50	65	7.35	.15
55	30	7.50	OPTIMAL BRANCH INVENTORY LEVEL
60	1.7	7.43	.07
65	.8	7.32	.18

Figure 14—SOBIL System, Computer Print-Out

balancing of revenues and costs generated by inventory. Furthermore, for any given amount of capital invested in inventory, the best possible distribution of this inventory can be obtained between the branches and for the different items, and the total investment in inventory can be controlled merely by changing the cost of capital. Finally, when policy considerations dictate establishing branch warehouse inventories at levels other than those indicated as optimal by the SOBIL System, the amount of short-run profit which is foregone by this policy is readily calculable.

Acknowledgements

This article discusses some continuing research which is being done for the Replacement Division of Thompson Products by the Management Sciences Department of The Ramo-Wooldridge Corporation. This work represents a team effort, and it is difficult adequately to delineate the parts for which various people are responsible. The members of the Ramo-Wooldridge team who, at various times, were involved in this project include Mr. W. R. Hydeman, Dr. William Karush, Mr. L. A. Moody, Mr. A. F. Moravec, Dr. A. Vazsonyi, Mr. Jack K. Weinstock, and Dr. David M. Young. The author's own contributions, conceived in close collaboration with Mr. Moravec, were mainly connected with developing the decision rules for determining optimal branch warehouse inventory levels (based on the relation between expected lost sales and inventory) and the general economic analysis of the Monte Carlo model's relevance to the Replacement Division's operations.

The members of the Management Sciences Department's study team are especially grateful to Mr. Kenneth C. Lucas of Thompson Products' Replacement Division for his patience, advice, and cooperation during this project. The author wishes to thank Messrs. Hydeman and Moravec for their personal help and encouragement while the three of us were in Cleveland working on the implementation of the Monte Carlo model.

Multi-level Continuous **Sampling Procedures and Tables** *for Inspection by Attributes*

W. GRANT IRESON and RICHARD E. BIEDENBENDER*

Introduction

Background

The possibility of effecting further reductions in the sampling rates of continuous attribute sampling plans, when the process exhibits a quality level much better than the AOQL, has probably interested many people in the SQC field. Within the Air Force, this feeling reached its peak approximately five years ago, when the Air Force proposed application of such a plan to the green-run teardown inspection of newly procured aircraft engines. Joint Air Force and Industry study on this problem eventually resulted in the development of a continuous attribute sampling plan, which had three sampling rates—one-half, one-fourth, and one-tenth. This plan was successful from the start.

A review of other inspection and test areas indicated that such plans could be used to advantage in a number of them. Therefore, when the problem of developing a general mathematical model for such plans was solved by several sources† outside the Air Force in 1954, the Air Force‡ decided to let a contract to Stanford University to prepare a complete set of multi-level plans, written for use by personnel without sophisticated statistical backgrounds.

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†See Ref. 1. Also, Dr. Joseph A. Greenwood, then of the Bureau of Aeronautics, in an unpublished paper in 1954, presented a solution to the problem of a mathematical model.

‡The authors wish to acknowledge the initiative in this direction to Mr. John J. Riordan, then of the Quality Analysis Group in the Quality Control Office, Air Materiel Command.

The Approach to the Problem

It was felt that administrative feasibility and simplicity in use were as important as the statistical aspects of the plans. Stanford's project staff was therefore divided into two groups—one assigned to the theoretical problems, the other to the managerial and administrative problems. The first group studied various possible models; the second group visited AF Maintenance Depots and AF contractors to view such plans in operation and to discuss potential areas of application.

A number of mathematical models were developed, based on work available at that time. When these models were considered in conjunction with data gathered on the administrative aspects, the following requirements were laid down for the sampling plans:

a. All plans should provide protection against spottiness.

b. This protection should be accomplished by:

   (1) Inspecting a series of R successive items every time a defective is found.

   (2) Providing a method that will prevent the acceptance, without an inspection, of more than some given number of successive items.

c. The plans should have a constant i (the number of items which must successively be accepted to qualify for a reduction in inspection effort) for all levels of any given AOQL.

d. The rate of change of sampling from level to level would be by geometric progression, $f, f^2, f^3, \ldots, f^k$.

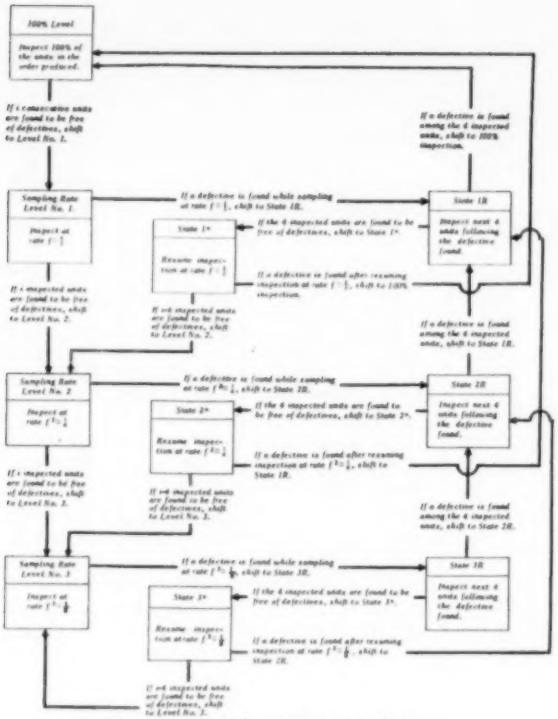

Figure 1—Multi-Level Schematic Diagram

e. Some rational method of selecting the plan of the most appropriate number of levels of finite production quantities was necessary.

f. The manual of plans should provide guidelines which would enable personnel without sophisticated statistical backgrounds to select and apply the plans. These guidelines must include suggestions for handling, in a simple fashion, such matters as random selection of samples and truncation limits for spottiness protection.

Any reader familiar with the Dodge-Torrey CSP-3 plans[2] will quickly note the similarity between those plans and requirements a., b.(1), and c. above. It can readily be seen that the above requirements amount to an extension to reduce the total amount of inspection necessary when quality was good.

It was also decided that plans and procedures developed would be service-tested at the San Bernardino Air Materiel Area. The results of the service testing proved very useful in determining the material finally included in the manual.

Applications

The original manual developed by Stanford was published as an Air Materiel Command Manual in September 1956. Applications to a variety of products, ranging from EAM cards to very complex equipments, were reported within the Air Force, with substantial savings.

Handbook Conversion

As part of the statistical program of the Office of Inspection and Quality Control, Department of Defense, to develop and publish new statistical quality control methodology in a form encouraging maximum utilization by all Department of Defense agencies, the Air Force was requested to convert the AF manual into a DOD Handbook.[3] Review and coordination of the original AF manual between the Services resulted in the inclusion of additional useful material in the DOD Handbook H106. The major features of H106 are reviewed in the remaining portion of this article.

Description of the Handbook

Contents

H106, "Multi-Level Continuous Sampling Procedures and Tables by Attributes," contains a complete description of the plans and administrative guidelines for their use. Plans with f = ½ and f = ⅓, with from one to five sampling levels, with an AOQL range from 0.10 to 15 percent are included. Tables and curves providing guidance in selecting the number of levels to use, as well as the standard AFI and AOQ curves, are given.

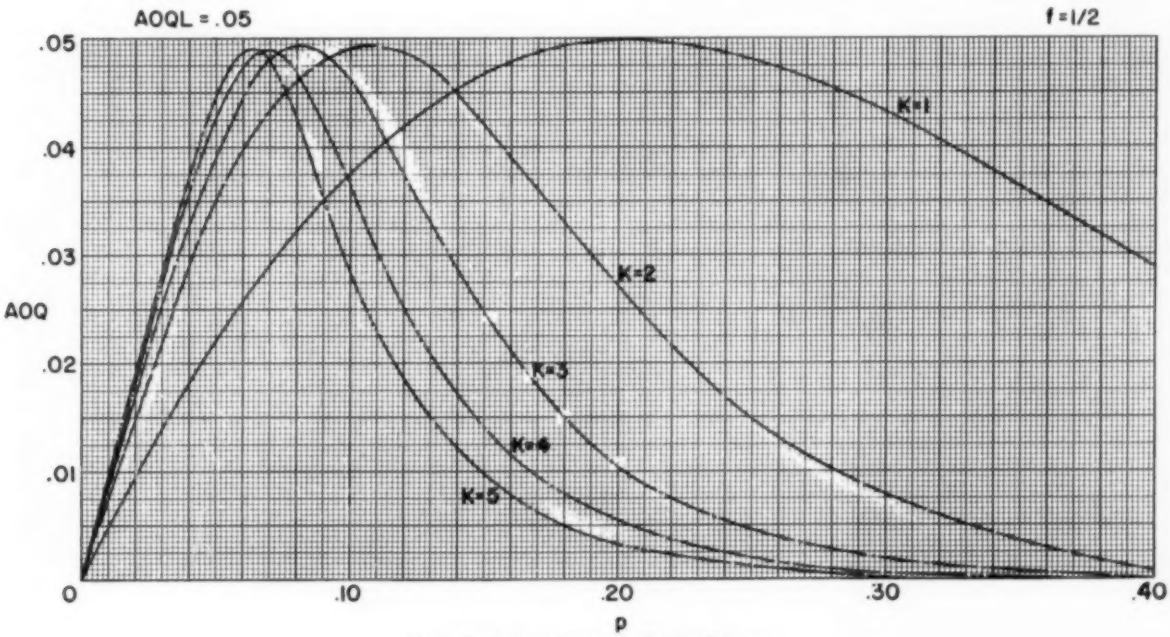

Figure 2—Average Outgoing Quality Curves

Random sampling and truncation procedures and methods for estimating incoming and outgoing quality are described. The relationships between the AQLs and accompanying AOQLs of MIL-STD-105B, "Sampling Procedures and Tables for Inspection by Attributes," and the AOQLs of H106, are included to facilitate substitution of one type of plan for the other, when considered desirable.

General Description

H106 sampling plans provide a procedure whereby the fraction inspected, of the presented items, is decreased or increased by steps or levels, dependent upon the quality of the presented items. When application to a product is started, 100 percent of the product is inspected until a specified number of consecutive items, i, is found free of defects. At that time, the inspection is reduced to a fraction, f, of the items presented. If i successively inspected items are found free of defects, the inspection rate is reduced to a new fraction, f^2, of the items presented. This procedure is continued throughout the several levels of the plan. If at any level, however, a defective item is found before i successively inspected items are passed, the plan provides a "spottiness" check to determine whether sampling should continue at the present rate or revert to the previous sampling rate.

The spottiness check is similar to the type of protection against spottiness used by the Dodge-Torrey CSP-3 plans. An examination of the schematic diagram (Fig. 1) will best serve to give the reader an understanding of the procedure followed. Although this schematic shows only three levels, plans with from one to five levels are contained in the manual. To obtain a schematic for a different number of levels, simply add to or subtract from the middle levels.

The plans are described by three parameters, i, k, and f. The number of successively inspected items that must be found acceptable in order to shift to a smaller sampling rate is i. The number of sampling levels that may be used is given by k, and varies from one to five. The first sampling rate after leaving 100 percent inspection is f, and each succeeding sampling rate is the same fraction raised to one larger power. Thus, for a five-level plan, the sampling rates are 100 percent, f, f^2, f^3, f^4, and f^5. For example: if $f = \frac{1}{2}$, the successive rates are $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$ and $\frac{1}{32}$. If the number of levels is less than five, the last rate corresponds to the rate at the last level, i.e., if three levels are used, the last sampling rate is $\frac{1}{8}$. The plans are indexed in terms of the AOQL (Average Outgoing Quality Limit). The underlying mathematical theory can be set up employing the Markov chain process.

TABLE I—Values of i for Multi-Level Plans
$f = \frac{1}{2}$, k = number of sampling levels

AOQL (in percent defective)	k = 1	k = 2	k = 3	k = 4	k = 5
15.0	*	*	*	4	5
10.0	*	4	6	8	9
7.5	*	6	9	11	13
5.0	5	11	15	18	20
3.0	11	20	26	31	34
2.0	18	31	40	47	51
1.5	25	43	55	63	69
1.0	39	65	83	95	104
0.75	54	88	112	128	140
0.50	82	133	168	193	210
0.35	119	197	241	275	302
0.25	167	269	337	386	422
0.15	281	446	564	636	706
0.10	421	675	847	969	1059

Range of Plans

Table I shows the plans available using $f = \frac{1}{2}$. Note that for the same AOQL each additional level requires an increase in the value of i.

AFI and AOQ Curves

The AFI and AOQ curves for the plans reveal some interesting characteristics of the plans. Figure 2 shows the AOQ curves for the 5 percent AOQL plan with different k values. Fig. 3 shows the AFI curves for the 5 percent AOQL plan with different k values. For either very good or very bad quality with respect to

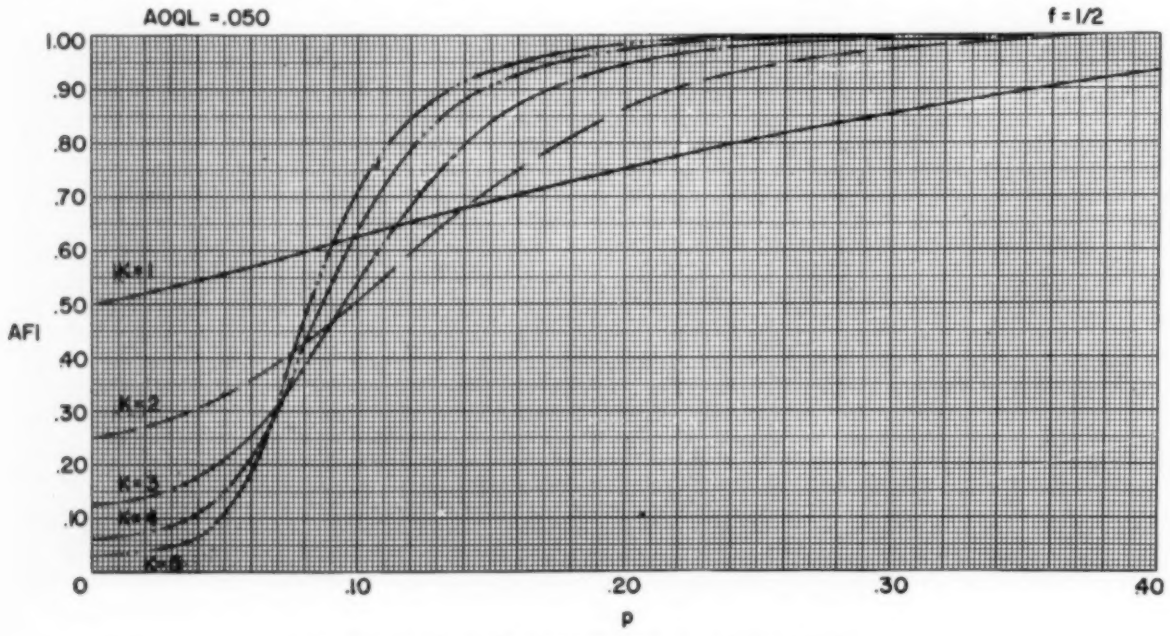

Figure 3—Average Fraction Inspected Curves for Varying k Values

N		AOQL (in percent defective)													
CONTRACT SIZE OR PRODUCTION RATE		.10	.15	.25	.35	.50	.75	1.0	1.5	2.0	3.0	5.0	7.5	10.0	15.0
4 – 65	i k											5 1		4 2	
66 – 135	i k									18 1	11 1				
136 – 200	i k								25 1				6 2		
201 – 300	i k							39 1				11 2			
301 – 400	i k										20 2				
401 – 500	i k						54 1			31 2				6 3	
501 – 700	i k					82 1			43 2				9 3		4 4
701 – 1100	i k				119 1			65 2				15 3			
1101 – 1500	i k			167 1							26 3			8 4	
1501 – 2700	i k		218 1				88 2			40 3		18 4	11 4		
2701 – 4000	i k	421 1			197 2	132 2			55 3		31 4				
4001 – 5500	i k			269 2						47 4					
5501 – 8500	i k		446 2					83 3	63 4						
8501 – 10500	i k					168 3	112 3								
10501 – 15000	i k	675 2			241 3			95 4							
15001 – 2100	i k			337 3		193 4	128 4								
21001 – 32000	i k		564 3		275 4										
32001 – 50000	i k	847 3		386 4											
50001 – 80000	i k		636 4												
80001 – 150000	i k	969 4													
150001 AND OVER	i k	1059 5	706 5	422 5	302 5	210 5	140 5	104 5	69 5	51 5	34 5	20 5	13 5	9 5	5 5

Table II—Values of i and k for Varying Contract Size and AOQL

the AOQL, the highest level plans are the most efficient, in the sense that they either minimize or maximize inspection as desired. Figure 4 shows AFI curves for 5 percent AOQL and constant level k = 2, but with different f's. Again, the results can be anticipated, and again the lower f value is the most efficient in the same sense as above.

Selection of a Plan

One of the problems in continuous sampling plans has been the logical selection of the i and f values for a plan after the AOQL had been set. In these plans, since f is already normally set, this problem shifts to the question of what level plan should be chosen. This can easily be done when the production quantity is exceedingly large, since the AFI curves would then be good approximations. However, it is also obvious that for finite quantities small enough, more inspection could be required if, for example, a k = 2 plan were used instead of a k = 1 plan; this could be true even though quality was very good. To fully understand how this is so, consider the following hypothetical case. Assume quality is perfect, production is only a total of 20 items, and the AOQL is 5 percent. Use of Table I reveals that a one level plan (i = 5) would theoretically inspect 5 + (20 − 5)/2 = 12.5 items; proceeding similarly, a two level plan would inspect 15.5 items and a k = 1 plan is actually more efficient. Availability of good quality histories reduces this problem somewhat, since it may then be feasible to begin sampling at one of the lower levels. However, since extensive records are not always available, a better solution was desired for selecting the level plan to use for a finite production run. In studying this problem, it was decided to concentrate on solutions which would minimize total inspection when quality was good, that is, equal to or better than the specified AOQL. Theoretical studies resulted in equations of such complexity that they were abandoned. Monte Carlo techniques were then employed, with surprising results. Figure 5 shows the average fraction inspected for the different k levels for increasing sizes of production runs.

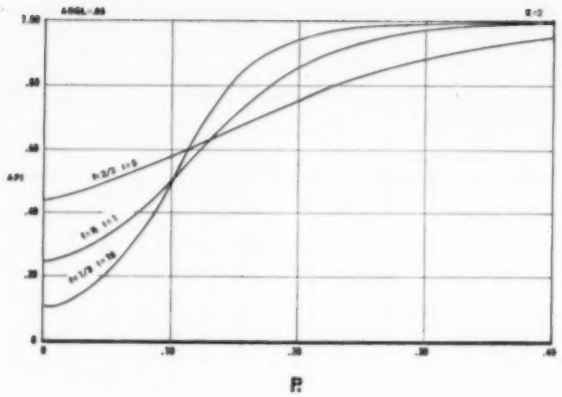

Figure 4—Average Fraction Inspected Curves for Varying f Values

The incoming quality is assumed to be equal to the AOQL.

Decision rules for level selection based on curves such as these are incorporated into tables in the manual (see Table II, page 13).

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(1) Lieberman, Gerald J., and Solomon, Herbert, "Multi-Level Continuous Sampling Plans", *Technical Report No. 17*, September 1, 1954, ONR Contract N6-onr-25126

(2) Dodge, Harold F., and Torrey, Mary N., "Additional Continuous Sampling Plans," *Industrial Quality Control*, Vol. VII, No. 5, Mar. 1951, p. 7-12

(3) *Inspection and Quality Control Handbook H-106*, "Multi-Level Continuous Sampling Procedures and Tables for Inspection by Attributes," July 1, 1958, Supt. of Documents, U.S. Government Printing Office, Washington 25, D. C.

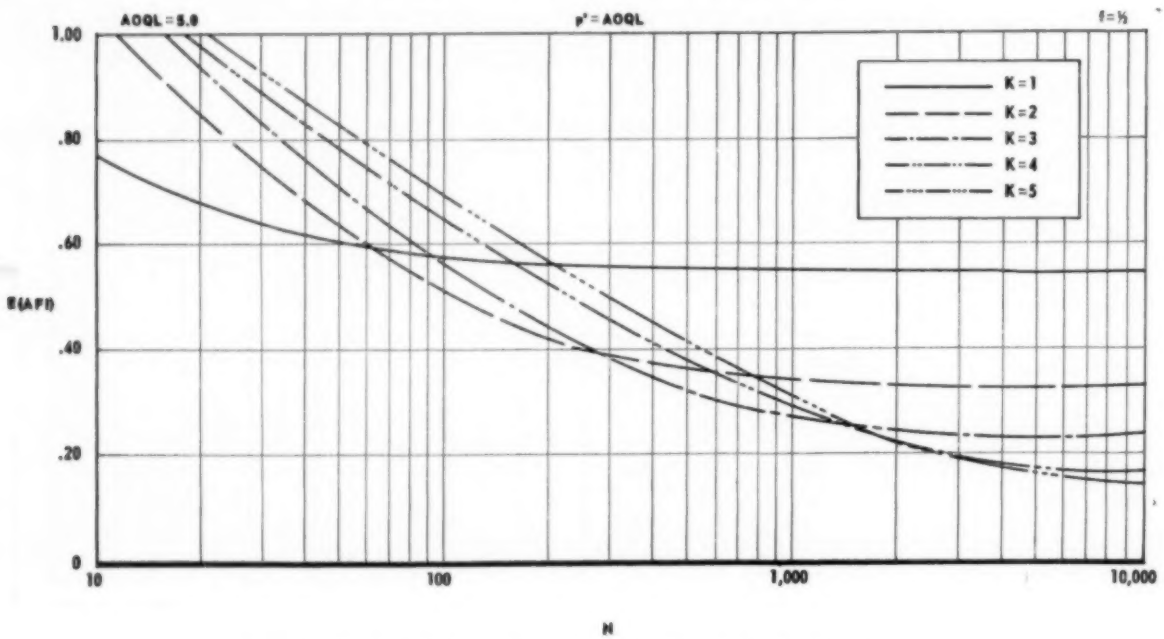

Figure 5—Average Fraction Inspected Curves for Varying Size of Production Run

Interpreting Straight Line Relationships

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Straight line relationships are as innocent, just about as frequent, and as difficult to comprehend fully as a little boy's questions. Beginning algebra books show how to draw them; lots of experimental data follow them reasonably closely, but, algebra deals only with points exactly on a line and empirical data are rarely so well behaved. This leads to all sorts of practical problems such as whether to draw a line through empirical points free-hand or use a more sophisticated approach. Is the line from which the points deviate least any better than a line drawn free hand? If so, how does one go about finding it and does it have any virtues to its credit other than the obvious one? Since there exists a choice in the positioning of the line, how much faith is warranted in an interpretation derived from any particular choice of line? Won't the answers to such questions depend upon the kind and reliability of the interpretation to be made? The following remarks are addressed to these questions.

In the study of heat transfer, the logarithms of corresponding Nusselt and Reynolds' numbers appear to be linearly related. Adjustment may be necessary for Prandtl number differences in order to achieve linearity. We begin with the relationship

$$Nu = C(Re)^B(Pr)^K$$

where

Nu = Nusselt No.

Re = Reynolds No.

Pr = Prandtl No.

C, B and K are constants

Taking natural logarithms:

$$Ln\left[(Nu)/(Pr)^K\right] = LnC + BLn(Re),$$

which is of the form of the equation of a straight line

$$Y = A + BX.$$

For simplicity, we will use this latter form where we have taken:

$$Y = Ln\left[(Nu)/(Pr)^K\right]$$

$$A = LnC$$

$$X = Ln(Re).$$

Also, for simplicity, we will assume that K is known.

For A and B fixed, Y and X may be permitted to vary but will always lie exactly on a straight line if they satisfy the equation $Y = A + BX$. If, for example, $A = 0.06$, $B = 0.8$, Y and X values that satisfy $Y = 0.06 + 0.8X$ lie on the line shown in Fig. 1.

Since we do not expect our experimental data to fall exactly on any straight line, we should distinguish between Y as given by the equation and the y we observe, both considered perhaps for the same X. Then $y = Y + e$ where e is simply the departure of observed y from the straight line Y at any particular X.

One line that is uniquely defined for any set of observed points is the one that minimizes the sum of squares of the e's. Its claim to being the line of best fit depends largely upon its one apparent virtue but also on a number of other less obvious requirements that may not always be satisfied. If these other requirements are not met, minimum sum of squares of departures of observations from the line may be something less than best. The method of least squares is so well known, however, and the uniqueness of its product so appealing that it will no doubt continue for some time as the usual method.

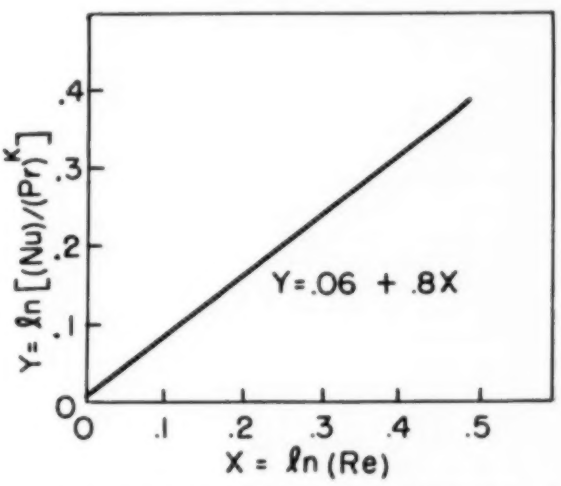

Figure 1—Relationship Between Ln(Nu) and Ln(Re) for Constant (Pr) and for Selected Constants

TABLE I—Pairs of Values of $y = \text{Ln}\,[(Nu \times 10^{-3})/(Pr)^{0.4}]$ and $X = \text{Ln}(Re \times 10^{-5})$

y	X
−0.3929	0.5417
−0.9978	0.0060
−0.5986	0.3542
−0.8564	−0.2303
−1.6724	−1.0524
−1.7430	−1.0496
−2.1144	−1.6100
−0.5211	0.5429
−1.0167	−0.0240

Any elementary statistics text contains detailed instructions on how to fit by least squares[1] and, with more requirements met, formulas for estimating the so-called confidence limits on A and B, confidence limits on the line, tolerance limits on y, tests of the linearity of the fit, etc.[2] These statistics are supposed to help us interpret the straight line relationship. Do they? And if so, how?

We will not go into the detailed requirements that justify the use of the method of least squares and the computation of these statistics. Rather, it is the purpose of this article to show that many experimenters who are willing to make the necessary assumptions to utilize the method do not go on to exploit them for all they are worth. Perhaps an example will best illustrate the point.

Table I shows nine pairs of numbers from a heat transfer experiment and Fig. 2 shows how the number pairs look graphically. The least squares line shown in Fig. 2 is:

$$Y = -0.8869 + 0.7660X$$

which is equivalent to:

$$(Nu)/(Pr)^4 = 0.0611(Re)^{0.766}$$

Actually

$$y = -0.8869 + 0.7660X + e.$$

Practically, it is important to know why the e's exist, that is, why the observed y's do not fall exactly on any straight line. This may be due solely to measurement error; on the other hand, it may be an inherent property of the test elements or test equipment. In either case, the pair of y's at X approximately equal to 0.54 and the pair of y's at X approximately equal to −1.05 suggest that another experiment even with the X's chosen as in the present experiment would not yield precisely the same line. That is, the least squares line, albeit unique in any single experiment, must be expected to vary in repeated experiments. There may indeed be some true line Y=A+BX where Y is the average y for a particular X but our line Y = −0.8869 + 0.7660 must be only an approximation to it. Thus −0.8869 is only an estimate of A and 0.7660 is only an estimate of B.

At this point, statistics furnishes us with estimates of the average square of error in the estimators of A and B. If we set

$\hat{A}$ = Estimator of A = −0.8869 in the example

and

$\hat{B}$ = Estimator of B = 0.7660 in the example

and also set

$V(\hat{A})$ = Average $(\hat{A} - A)^2$

and

$V(\hat{B})$ = Average $(\hat{B} - B)^2$,

statistical theory tells us that

$$V(\hat{A}) = \left(\frac{1}{n} + \bar{X}^2\right)\sigma^2$$

and

$$V(\hat{B}) = \sigma^2/Sx^2$$

where

$x = X - (\text{Average } X) = X - \bar{X}$

σ^2 = Average $(y - Y)^2$ = Average square of departure of y from the true line

and

n = number of number pairs.

We will not worry here about how these well known statistical results come about but rather concern ourselves with what, if anything, they have to contribute toward a proper use of our straight line in interpreting our data.

One important consideration from the standpoint of how to select X's so as to minimize the average square of error in $\hat{A}$ and $\hat{B}$ is now as obvious as the linearity itself: $V(\hat{A})$ will be a minimum for average X equal to zero and $V(\hat{B})$ will be a minimum for maximum spread

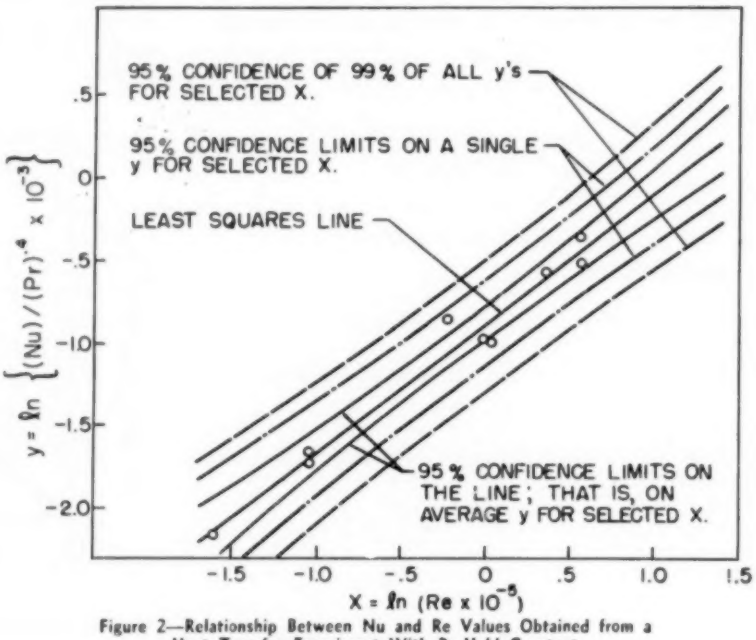

Figure 2—Relationship Between Nu and Re Values Obtained from a Heat Transfer Experiment With Pr Held Constant

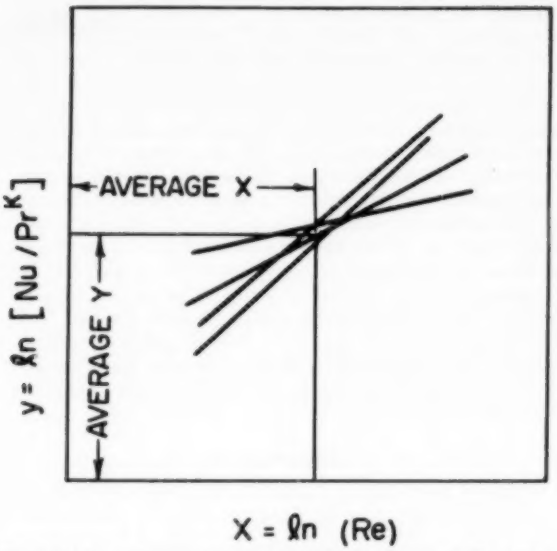

Figure 3—Least Squares Lines as They Might Appear in Four Heat Transfer Experiments

(sum of squares) of the X's about their average. This makes excellent sense, for intuitively we expect the line to vary essentially about the pivot point $(\bar{X}, \bar{y})$. We expect to measure the Y at $\bar{X}$ more accurately than any other Y. But $Y = A + BX$; that is, $Y = A$ for $X = 0$. To make $Y = A$ the most accurately measured Y we must take $\bar{X} = 0$. Since B is the slope of the line and since $\hat{B}$ is affected most seriously by y's at extreme X's, we must spread the X's about their mean to insure maximum precison in $\hat{B}$ as an estimate of B.

These design requirements for maximum precision on $\hat{A}$ and $\hat{B}$ are not necessarily compatible with the design requirements for the maximum precison on Y's for X's within the experimental range of X's. Here, then, is a conflict that is not easily resolved. To design the experiment efficiently (that is, to select the best set of X's at which to observe y's) one must decide whether the objective is to estimate A and B precisely in the equation $Y = A + BX$ or whether the goal is to achieve accurate prediction of the Y or y in a desired range of X's. If the desired range of X's does not average at zero, the two goals are not compatible from the standpoint of efficient design.

The experiment from which the above data derived was designed to measure y over the chosen range of X; hence one must not be dismayed to find the limits on C so computed as to include C with 95 percent assurance,

$$0.019 < C < 0.227,$$

wider than might be desired. The point on the curve corresponding to $Y = C$ lies to the left of $X = -11$ and approximately at $y = -12$ (see Fig. 2). It is easy to forget that precise measurement of a straight line over a fixed range of X is not equivalent to precise measurement of the A and B of the equation. We like to think of A simply as a constant of the equation, but it is also a value of Y for an X that may be remote from the experimental X's.

In the analysis of 95 percent of experiments that might be run, inequalities computed as was $0.019 < C < 0.227$ will hold. The similar inequality for B is $0.651 < B < 0.881$. These would appear to be useful measures of the precision of estimation of A and B. Now, how about the precision with which we estimate Y or y? Does statistics offer us any assistance here?

No interpretation of empirical data is ever free of assumptions, though oftentimes, because the assumptions are not explicitly stated, they are assumed to be non-existent. Consequently, we tend to be just a little prudish and reject as unwarranted the statistical requirements for the computation of confidence intervals even though we don't blush to assume linearity or even to fit by least squares. Most efforts at fitting free hand lines to empirical data probably incorporate assumptions not unlike those involved in the method of least squares. Invariably the departures of observed points from the line are interpreted as a measure of the goodness of fit and often, therefore, as a measure of the reliability of the interpretation based on the line. Statistics does nothing more than this when it uses these departures to plug in an estimate of the only unknown quantity, σ^2, in the expressions given above for $V(\hat{A})$ and $V(\hat{B})$. Moreover, a check on the validity of such a procedure can easily be incorporated into the experiment. An obvious procedure for testing the adequacy of a straight line is to compare the departures from it with those among several observed y's all at the same X; the details of one such test are contained in most elementary statistics texts.[3][4] It is difficult to challenge the appropriateness of such a comparison even if one is reluctant to accept the text-book rule for abandoning the hypothesis of linearity in any specific situation. When we reject the hypothesis of linearity for points such as those in Fig. 4, we are doing so because the ordered departures from the line exhibit distinctly non-random tendencies. Tests of randomness of an ordered set of points are also easy to find.[5]

Tests, such as those described above, are little more than formalizations of common-sense interpretations of data. Confidence intervals for B and C in the heat transfer equation are not much different. Their greatest misuse stems less from a failure of the necessary assumptions to hold than from the failure to interpret them properly.

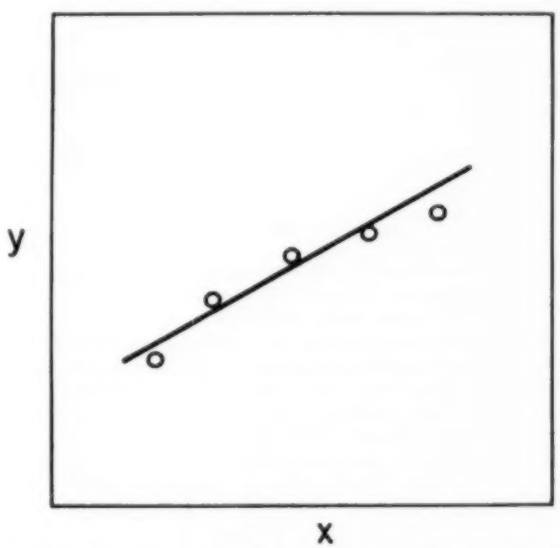

Figure 4—A Near Linear Relationship Between Any Hypothetical Pairs of Numbers

A straight line was fitted to the heat-transfer data to set certain of the design parameters for a nuclear power reactor. It is important to design reactors safely; so the heat-transfer coefficient must not be overestimated. One would like to obtain from the empirical data not only an estimate but also some kind of lower limit to the heat-transfer coefficient that may be encountered in the reactor.

Figure 2 shows the least squares line from which we may estimate Y for any chosen X. The solid line hyperbola represents 95 percent confidence limits for the straight line or, what is equivalent, for Y, the mean value of y for any chosen X. Ninety-five percent confidence limits for a single y measured at any chosen X are given by the dashed line intermediate hyperbola. Ninety-five percent confidence limits for 99 percent of all possible y's at a chosen X are shown in the outermost hyperbola. These limits bear the same relationship to average y or Y, to a single y, and to 99 percent of all observable y's respectively as did similar intervals computed for A and B, namely that 95 percent of intervals so computed do indeed include the quantity being estimated. Admittedly the validity of such intervals depend upon certain assumptions not the least of which is that of linearity, but, for practical interpretation the more important question is why y departs from the straight line relationship at all.

If, at a chosen X, y departs from the line only because we do not measure true Υ, the lower branch of the solid line hyperbola may provide a suitable lower limit. On the other hand, y at a chosen X may depart from true Υ because of measurement error, but true Υ may depart from average y, Y, because true Υ may itself be variable due to manufacturing and assembly tolerances or due to inherent variability in flow conditions. If so, it may be necessary to choose the lower branch of the outermost hyperbola as a suitable lower limit. Even though experimentation designed to decide which is true be expensive, it may turn out to be less expensive than continually over-designing reactors for safety. No one of the confidence intervals is truly a 95 percent confidence interval if the assumption of linearity be false. Methods for testing such basic assumptions ought to be exploited for all they are worth. This is not to cast doubt upon published and well accepted results. It is known, however, that at least for burn-out data various authors have achieved apparent linearity by different methods, suggesting that there is still doubt about the true relationship.

References

(1) Dixon and Massey, *Introduction to Statistical Analysis*, Second Edition, McGraw Hill, p. 191-196

(2) Bennett and Franklin, *Statistical Analysis In Chemistry and the Chemical Industry*, John Wiley and Sons, Inc., p. 222-232

(3) Cochran and Cox, *Experimental Designs*, Second Edition, John Wiley and Sons, Inc., p. 121-124

(4) Snedecor, *Statistical Methods*, 3rd editon, Iowa State College Press, p. 208 and p. 225-228

(5) Dixon and Massey, *Ibid.*, p. 287-289 and p. 298-299

Who Controls Quality . . . . . and How?

WARREN R. PURCELL

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Introduction

Picture a manufacturing organization with inspection and quality control groups which perform their functions perfectly. The chief inspector is a genius at administration, as is the quality control manager. All inspection, measuring, and test equipment is maintained in excellent condition. Inspectors never err, even on visual characteristics. The sampling plans in use maintain just the right balance between cost of inspection and cost of wrong acceptance decisions. The quality control group supplies reliable quality data in useful form, and is well staffed with quality control engineers who have unusual ability to diagnose process ills quickly and accurately and make recommendations which, if followed, would eventually eliminate all quality troubles.

Would such a manufacturing organization have quality troubles?

Of course it would.

Why?

The answer is well known and has frequently been stated. It is this: quality is controlled by many persons, and most of them are in neither the inspection nor quality control groups. They are in many other groups, including General Management, Accounting, Research and Development, Design, Planning, Purchasing, Production, Production Control, Industrial Engineering, and Sales.

How can these groups help in the control of quality? What, specifically, can they do?

To help in answering these questions the following suggestions are made. Admittedly, the list is not complete. It is requested that other ideas which occur to

readers be submitted in letters to the Editor of *Industrial Quality Control.*

General Management

1. *Maintain a consistent quality policy.*

   There will be occasional quality failures. Do not let an occasional failure, exaggerated out of proportion because of the particular persons affected, cause an excited drive to tighten up inspection. For this starts the oscillation of the pendulum between quality at the price of quantity and quantity at the price of quality.

2. *Keep informed on the total cost of quality.*

   These costs fall into three broad categories: prevention, appraisal, and failure. This has been pointed out by Feigenbaum.* Count the total, the total counts. An increase in one category associated with a greater decrease in the others is good; a decrease in one category associated with a greater increase in the others is bad.

3. *Keep informed on "market quality."*

   If your quality is poorer than that of your competitors, you are in grave danger. If it is better by a wide margin, your quality costs may be too high.

4. *Maintain the balance between know-how and open minds.*

   Create an atmosphere in which all the know-how in the organization may be used, but do not let opinions stand in the way of finding facts.

Accounting

1. *Maintain adequate records of internal quality costs.*

   For general management, the breakdown into prevention, appraisal, and failure may be enough. For the quality control manager, however, these should be further broken down by cost centers, parts, defects, and other classifications. For the essence of good quality control management is the concentration of adequate quality control skills at the points of concentration of quality costs.

2. *Maintain adequate records of the quality costs of purchased material, parts, and assemblies.*

   The costs of source inspection, detail sorting of lots rejected by sampling, rework by the vendee, and other costs generated by poor purchased quality are not properly chargeable to Inspection or Quality Control; they are incurred by Purchasing. They should be charged to Purchasing, which should, at its discretion, charge them in turn to the vendor.

Research and Development

1. *Make full use of modern techniques of experimenting.*

   Decisions made by Research and Development have important effects on quality and its control. Choices are made among materials, methods of testing them, methods of processing them. Many of these decisions are reached by running experiments. The traditional methods of experimenting are not only costly and inefficient; they also yield wrong answers. The Research and Development group which does not use modern techniques of experimenting is simply putting its company out of competition.

2. *Beware of the sensitive process.*

   A process requiring close control may succeed in the laboratory, but be too sensitive for the factory with its background of more severe variation. The search for a less sensitive process may pay handsomely in reducing the cost of quality.

*Feigenbaum, A. V., "The Challenge of Total Quality Control," *Industrial Quality Control*, Vol. XIII, No. 11, May 1957, p. 17-23.

Design

1. *Base design changes on factual feedback of information.*

   Design should be an active part of closed feedback loops, basing its changes on production difficulties, inspection results, and customer reactions. The information from these sources should be based on factual data which have been distilled by a reliable quality control staff.

2. *Recognize tolerancing as a major technique of engineering.*

   While there still remains some degree of guesswork in establishing tolerances, much progress has been made in developing a truly scientific approach to this important subject. The following principles are now generally recognized:

   (a) A tolerance is of no value unless there are means available to verify conformance to it.

   (b) The tolerance capability of a process can be measured scientifically.

   (c) Limitation of designs by the extremes of possible tolerance combinations is unrealistic pessimism.

3. *Analyze designs for potential quality troubles.*

   The Production and Quality Control groups provide valuable feedback information on this problem.

4. *Allow an adequate "proving-in" period for new designs.*

   Do not be misled by a test of too few pieces, or by the fallacies of traditional methods of experimenting.

Planning

1. *Use manufacturing equipment capable of meeting engineering tolerances.*

   Do not depend entirely on unsupported claims. Have the equipment accuracy capability analyzed by competent quality control engineers.

2. *Use inspection and test equipment compatible with the accuracies required.*

   Do not depend entirely on unsupported claims. Have the equipment accuracy checked by competent quality control engineers.

3. *Before buying new equipment for quality reasons, be sure the present equipment is doing the best it can.*

   Do not depend entirely on unsupported statements. Have the accuracy capability of the present equipment analyzed by competent quality control engineers.

4. *Consider the quality aspects of the locations of inspection and test areas.*

   The following questions, among others, arise:

   (a) Can adequate lighting be provided?

   (b) Can adequate freedom from noise, vibration, dust, and other troublesome environments be provided?

   (c) Is receiving inspection near the receiving area? Are inspection stations near their corresponding work flows?

Purchasing

1. *Assume the primary responsibility for the conformance of purchased material, parts and assemblies to engineering specifications.*

   The costs incurred by lack of conformance can properly be charged to the purchasing function.

2. *Keep informed on the costs of non-conformance of purchased material, parts, and assemblies.*

   Get information on these costs from accounting. Use the services of the quality control vendor rating system in selecting vendors.

3. *Initiate contracts with qualified vendors only.*

Qualification may be determined in one or more of three ways:

(a) Reputation for quality in products similar to the one for which a contract is being negotiated.

(b) Experience with the vendor on similar products.

(c) A quality control survey of the vendor's manufacturing and inspection facilities and procedures.

4. *Allow an adequate "proving-in" period for a vendor on material, parts, or assemblies he has not supplied before.*

In spite of reputation, experience, or an advance survey, the vendor may still encounter difficulties and/or misunderstandings. Advance samples shipped to the vendee for inspection and approval, prior to the start of a substantial run, are advisable.

5. *Secure deliveries early enough to permit adequate inspection and a free decision to accept or reject.*

If material, parts, or assemblies are so badly needed that they must be accepted even if non-conforming, quality trouble is in store.

6. *Accept, and secure acceptance from vendors, of the principle of lot rejections.*

Lots of acceptable quality should be the normal expectation. The verification of acceptability can usually be done by sampling inspection, at normal quality cost. If the lot quality is not acceptable, it can also be rejected at normal quality cost. The sorting of defectives, however, is an excessive quality cost, and should be borne by the vendor, not the vendee.

7. *Cooperate in programs of crosschecks of gauges and test equipment.*

Such crosschecks prevent misunderstandings between vendor and vendee. Sometimes the best method of cooperating is by letting the vendor's and vendee's quality control groups set up and operate the programs without interference.

Production

1. *Provide adequate quality training for operators.*

This is a platitude. But its importance must still be stressed. The difficulty is that immediate problems compete more severely for the supervisor's time than do longer-term problems such as training.

2. *Use in-process inspection as a service to production.*

In-process inspection prevents the expenditure of further cost on defectives. It also provides immediate feedback information for process control. In both respects it is a service, not a deterrent, to production.

3. *Do not ask process inspectors to supervise operators.*

It is sometimes suggested that roving inspectors point out directly to operators that their techniques or methods are faulty. This is a serious violation of the prerogatives of the production supervisor. Inspectors should criticize the product or the process, not the person.

4. *Do not expect acceptance inspectors to "flinch".*

The function of the acceptance inspector is to check the conformance of the piece to the specification. If it conforms, he accepts; if it does not conform, he rejects. That is the end of the acceptance inspector's function. Reconsideration of rejects should be appealed only to a higher authority. Breaking of this policy is the beginning of loss of control.

5. *Use the simpler modern quality control techniques as production tools.*

There have been developed several modern quality control techniques which require little statistical skill but are based on pure logic. Operators should use these as tools of their own; not as tools which can be handled only by specialists.

6. *Attack the chronic quality problems.*

The sporadic problems compete harder for attention, but the chronic problems are usually the more costly.

7. *Call in the specialists as soon as necessary.*

Some of the chronic quality problems do not yield to the shop know-how, even when supplemented by the simpler quality control techniques. When that point has been reached, call for the services of the specialists versed in the practical use of advanced quality control techniques.

Production Control

1. *Consider the quality advantages of long production runs.*

Scheduling quite properly attempts to find the balance between the high inventory costs of long production runs and the high manufacturing cost of short runs. Do not overlook the fact that quality costs, as well as production costs, are lower on longer runs.

2. *Consider the quality advantages of large lot sizes.*

Quality costs are lower on large lots.

3. *Consider the quality advantages of "first in first out."*

Quality changes occur during production, for both clear and obscure causes. Identification of the corresponding parts is easy under "first in first out", difficult under "last in first out."

4. *Allow time for adequate inspection and a free decision to accept or reject.*

If parts are so badly needed that they must be accepted even if non-conforming, quality trouble is in store.

Industrial Engineering

1. *Include adequate quality clauses in incentive plans.*

Strange as it may seem, there are incentive plans in existence which pay bonus for quantity without regard to quality. Most modern plans, however, do not pay for defective work. Nevertheless many of these plans fail to penalize for the inspection cost of finding the defectives. Such costs should also be charged against the incentive; otherwise the company pays for inspection in order to pay the quantity bonus to the operator.

2. *In studying inspection methods, consider inspection accuracy.*

The value of inspection should be measured not by the number of pieces going through the inspector's hands, but by the number of defective and non-defective pieces correctly identified.

3. *In time-studying inspection, consider inspection accuracy.*

The value of inspection should be measured not by the number of pieces going through the inspector's hands, but by the number of defective and non-defective pieces correctly identified. Furthermore, the speed of inspection is substantially affected by the number of borderline pieces on which decisions must be made.

Sales

1. *Do not exaggerate quality claims to the customer.*

The disappointed customer is the complaining customer.

2. *Do not exaggerate quality complaints to the factory.*
A comment such as: "Our quality was never as poor as it is now" may stir up people. But without specific, unexaggerated facts, the resulting poorly-directed activity is likely to do more harm than good.

3. *Encourage direct contact between factory and field.*
It has been shown that direct customer contact by a personable representative of quality control, with the contact controlled by Sales, not only provides feedback of factual quality information of value to the factory, but also improves customer relations.

Conclusion

The list could be further extended to include personnel, legal, marketing, advertising, industrial relations, receiving, shipping, maintenance, and other groups. Thus it appears that each person in the organization can make specific contributions to the success of quality control.

Everybody Controls Quality—And How!

Announcing the Birth of a New Professional Organization

Institute of Nuclear Materials Management

On August 1, 1958, a new professional organization was born: the Institute of Nuclear Materials Management. Several of ASQC's members are among those on the roll of this new organization, and all ASQC members will be very interested in the work and growth of the Institute.

The firms represented by the members of the Institute of Nuclear Materials Management are particularly indebted to statistical techniques of all types, including quality control techniques, for effective operations in the nuclear field. The members of the Institute, being leaders in their fields, are staunch advocates of those quality control and other statistical methods.

Article II of the Institute's Constitution summarizes the important and difficult purpose of the organization:

"In consideration of the high monetary value of the nuclear material consigned to industry and in view of the necessity for providing standards for the economic evaluation and interpretation of nuclear materials data which includes, but is not limited to, the determination of:

(a) nuclear material inventories
(b) burn-up
(c) nuclear material recovery
(d) nuclear material unaccounted for
(e) shipper-receiver discrepancies

This organization is formed (1) to establish and encourage the use of nuclear material management standards, criticality standards, and AEC License requirements (2) to encourage and coordinate educational activities in nuclear materials management by and between governmental agencies, industry and academic institutions (3) to promote publication and dissemination of information in this field (4) to provide an opportunity to meet and discuss problems of mutual interest and (5) to certify qualified individuals in the nuclear material management field."

Here again our profession is performing a vital service for others.

H. Alan Lasater, Union Carbide Chemicals Co., Oak Ridge, Tenn.

ANNUAL REPORT of the BOARD OF DIRECTORS

American Society for Quality Control, Inc.

The Board of Directors of the American Society For Quality Control, Inc., submits herewith its Annual Report covering the 1957-1958 year from July 1, 1957, through June 30, 1958.

This report summarizes the outstanding events of the year and the more important decisions made by the Board and its Operating and Executive Committees.

BOARD OF DIRECTORS

The first meeting of the Board was held on May 23, 1957, at the Sheraton-Cadillac Hotel in Detroit, Michigan. This meeting was for the purpose of electing the five executive directors to serve for the year 1957-1958. The men elected were:

David G. Browne
Rocco L. Fiaschetti
Ralph D. Humphries
August B. Mundel
Harry G. Romig

The mid-year meeting of the Board was held on November 16, 1957, at the Hotel Astor, Milwaukee, Wisconsin. At this meeting, a summary of the goals for the year, and the progress to date, was given by the President. Each officer reported on the activities in his area. After considerable discussion, the Board approved the recommendation of the Executive and Operating Committees to again submit to the membership for approval, an amendment concerning a modest dues increase. Mr. Fisher presented a number of additional proposed amendments to the Constitution and By-Laws Committee. These were approved by the Board for submission to the membership.

Mr. McElrath made a plea for a training session at the annual conventions. A motion was carried recommending that such a course be undertaken beginning in 1959.

Mr. Weaver, on behalf of the Financial Advisory Committee, commented on the financial condition, operating expenses, and mounting costs of Society operation. Exception to some of the statements was taken by the President.

A motion was made, and eventually passed by mail ballot, to ease the restrictions on the Financial Advisory Committee on the maximum ratio of stocks-to-bonds that it is required to meet in handling the investment portfolio.

EXECUTIVE AND OPERATING COMMITTEES

During the year the Operating and Executive Committees met six times:

May	25, 1957	Detroit, Michigan
July	26, 1957	Milwaukee, Wisconsin
September	20, 1957	Philadelphia, Pennsylvania
November	15, 1957	Milwaukee, Wisconsin
February	7, 1958	New York, New York
April	11, 1958	Cincinnati, Ohio

The principal actions taken by these committees were:

1. A policy was adopted for acquisition of divisional, regional, or sectional conference papers.
2. A rotation plan for membership on most committees of the Society was adopted.
3. The 100th ASQC section—Sacramento, California—was admitted to the Society.
4. A policy for naming of sections was adopted.
5. A decision was reached to implement a series of management programs at the section level with assistance in scheduling and programming to be given by the Program and Speakers Committee. Further assistance to the sections was planned through organized lecture series, a program and speakers list, and, at their request, special assistance to sections on programming.
6. The Personnel Policy Manual was revised and made current.
7. A new committee, known as the ASQC General Technical Council, was organized. This group consists of past and present chairmen of technical and professional committees and divisions. Through the holding of several meetings a year, an exchange of ideas and better communication, consequently better over-all Society operation, is expected.
8. Goals for the operation of the Society in 1957-1958 were adopted. These goals were summarized in the September 1957 issue of *Industrial Quality Control*.
9. In a move to provide faster and better service to the sections and divisions, approval was granted to have the Administrative Secretary sign checks for reimbursement of dues remittance to these groups. This was done to avoid the delay caused by forwarding checks from Milwaukee to Fort Worth.
10. A section visitation plan was adopted in an effort to see that all sections are visited at least once during the year by an officer or director of the Society.
11. A brochure slanted toward management was composed, printed, and distributed to the sections.
12. The Committee on Professional Development was implemented with additional members, and it met several times during the year. A six-point program was adopted and considerable progress was made.
13. Steps were taken to improve service to the divisions by placing division records on addressograph plates in the Milwaukee office. This reduced cost to the Society, and made more frequent membership lists possible. A new communication service to sections and divisions was established with the monthly publication of the "Intercom."
14. IBM services were transferred from Workman Service to Haywood Publishers in Chicago at an estimated savings of at least $4000 per year.
15. A proposal for the establishment and publication of a technical journal by the Chemical Division and the American Statistical Society was approved. Funds will be provided by these two groups.
16. A Group Health and Hospitalization Insurance Plan for members of the Society was proposed. A committee was appointed to make a further study of this plan, and to make recommendations to the Executive and Operating Committees. Adoption of such a plan could mean additional savings and an additional service to the members.
17. The proposal of the Ad Hoc Committee on Bibliography was adopted. ASQC will sponsor the distribution of the ISI Bibliography at a special price of $4.50 per year to our members.

COMMITTEE ON PROFESSIONAL DEVELOPMENT

The Committee on Professional Development undertook a six-step program concentrating both upon establishing the basic elements of quality control engineering work and in introducing this work into industry, the universities, and state licensing thinking. A great deal of emphasis is being placed upon using further professional development in quality control engineering work as the hard core of local section programming.

About half the work of the Committee was completed prior to the first of June. It is anticipated that the total program will be concluded by the end of the calendar year of 1958.

The sentiment within the Committee is unanimous in that the concept of truly professional quality control activity must become the basic common thread within the American Society for Quality Control.

ACKNOWLEDGMENTS

The Board gratefully acknowledges the continued services of the Officers; Executive Directors; Division, Technical, and Professional Committee Chairmen; and Section Officers and Members who contributed to the steady improvement of the Society. The Board also wishes to express special thanks to the Chairman of the Editorial Board and his Associates for their continued devotion and service to our journal, *Industrial Quality Control*.

The Society has completed a successful year despite certain handicaps. The Board is grateful to the speakers, teachers, committee members, and all the others who have contributed unselfishly of their time and effort.

Cincinnati, Ohio
June 30, 1958

For the Board of Directors
LEON BASS, *President*

Appendix A: Report of the Executive Secretary

Membership

Membership in ASQC continues its steady annual growth since formation of the Society in 1946. As of June 30, 1958, it reached a new high of 11,063. The net gain over June 30, 1957, is 566 or about 291 under the net gains for the last two years. Following is a membership breakdown as of June 30, 1958:

Member grade	8,929	Renewals	8,312
Senior grade	1,927	New Members	2,751
Fellow grade	207		
Total	11,063	Total	11,063
Mem.-in-tr.	71		

Since the last Annual Report the following new sections were admitted:

Section	No.
Phoenix (Arizona)	98
Battle Creek-Kalamazoo (Michigan)	99
Sacramento (California)	100
Piedmont (Carolinas)	101
St. Charles (Illinois)	102
Lexington (Kentucky)	103
Pensacola-Mobile (Florida-Alabama)	104
Tulsa (Oklahoma)	105

By actual count there are 102 active sections although 105 have been chartered. Mortality and amalgamation over the years accounts for the difference. In the current fiscal year the Burlington (Vermont) section surrendered its charter.

Headquarters Office

Your Headquarters Office has made great strides in improving its communications with members and sections. Two new manuals have been produced in the past year—a "Handbook for Section Officers" and another one for membership chairmen. In addition to these two new manuals, a new membership application form has been prepared and distributed along with a new information brochure on the Society and its activities. A special folder directed to industrial management was also produced.

To improve communications between the Headquarters Office and the section and division officers, a new bulletin service was inaugurated last fall—the new "ASQC Intercom." "Intercom" announces the monthly membership results and current Society activities and makes suggestions on section administration.

The punch-card system and procedures for our membership records have been undergoing steady changes to make them more economical and useful. A recent change has cut the costs of operation of this new system some 35 percent. To aid the divisions, special arrangements were made for division membership records and these went into effect in January, making the division records up-to-date for the first time and providing the right information to division officers on a current basis. The same general procedures also had been established in July for the section membership records giving the sections an opportunity to maintain their own lists on a current basis.

Every effort has been put forth to keep your Headquarters Office staff operating as efficiently as possible. During the year, because of the reduction of income from advertising revenues, your Headquarters staff was reduced by 15 percent. An intensive work study was performed so that this cut could be made without seriously affecting the services to members. This study also showed that if any further reduction is required, it will seriously hamper the efficiency of your Society office, and its ability to serve you.

This year two new services were offered to members: (1) the ASQC Personnel Listing Service, which allows members who are interested in changing their positions to notify the Headquarters Office and receive the monthly bulletin which shows the positions available for their contact, and (2) the establishment of a 20 percent discount on ASQC publications. It is sincerely hoped that the staff can be increased next year so that additional services to members can be offered.

Direct Collection of Dues

We wish to thank the great majority of sections for cooperating in direct collection of dues. Their participation has enabled the Society to utilize more economical procedures in processing the renewals and new membership applications. At the present time, only 10 sections are not on direct collection. During the coming year, we propose to furnish all participating sections with lists of their non-renewing members. With this information, their membership committees can contact these people promptly and thus increase their renewal rates.

Milwaukee, Wis.
June 30, 1958

L. S. EICHELBERGER
Executive Secretary

Exhibit A—Record of Membership Growth

Date	Members	Percent Renewals	Net Gain	Percent Gain	New Members	Active Sections	Members Rec'd. for Following Fiscal Year
June 30, 1947	1,926				1926	25	*
June 30, 1948	2,102	*	176	9.1	*	31	*
June 30, 1949	2,638	75.2	536	25.5	1058	35	*
June 30, 1950	3,510	76.7	872	33.1	1489	42	58
June 30, 1951	4,245	80.5	735	20.9	1422	48	167
June 30, 1952	6,109	81.2	1864	44.0	2669	60	207
June 30, 1953	7,430	75.0	1321	21.6	2846	71	146
June 30, 1954	8,548	77.5	1118	15.1	2798	80	254
June 30, 1955	8,780	74.7	232	2.7	2399	86	177
June 30, 1956	9,673	78.6	891	10.3	2781	92	184
June 30, 1957	10,497	78.3	824	8.5	2924	97	174
June 30, 1958	11,063	79.2	566	5.4	2751	102	207

*No Record

Exhibit B—Membership Report, 1957-58

	Membership June 30, 1957		Membership June 30, 1958		
	Total	F*	S*	M*	Total
District 1					
Boston	209	8	41	209	258
Burlington	15				
Buzzards Bay	40		2	25	27
Hartford	137	1	28	109	138
New Hampshire	23		10	27	37
New Haven	82		23	55	78
Pittsfield	55			65	65
Rhode Island	67	3	13	52	68
Southern Connecticut	150	1	40	111	152
Western Massachusetts	72	3	14	48	65
Worcester	75	2	8	58	68
Total	925	18	179	759	956
District 2					
Albany	79	5	18	65	88
Binghamton	90		11	122	133
Buffalo	93	2	22	72	96
Corning-Elmira	139		11	103	114
Mid-Hudson	109	3	8	94	105
Rochester	133	10	64	69	143
Syracuse	104	2	27	96	125
Utica	31		5	31	36
Total	778	22	166	652	840
District 3					
Metropolitan	763	26	151	607	784
District 4					
Hamilton	52	3	4	45	52
Montreal	124	3	13	168	184
St. Catharines	30		1	18	19
Toronto	117	1	19	118	138
Western Ontario	57		4	36	40
Windsor	43		8	70	78
Total	423	7	49	455	511
District 5					
Allentown-Bethlehem	102	1	11	87	99
Danville-Sunbury	29		3	63	66
Erie	46		5	37	42
Harrisburg	143		15	118	133
Lansdale	50	2	9	44	55
Philadelphia	278	5	74	222	301
Pittsburgh	133	6	39	98	143
Scranton-Wilkes-B	61		8	34	42
Trenton	38		8	27	35
Total	880	14	172	730	916
District 6					
Baltimore	121	4	20	118	142
Piedmont	36		12	56	68
Cumberland	34		2	41	43
Delaware	82	4	10	66	80
Richmond, Va.	48	1	10	41	52
Washington	121	5	21	81	107
Total	442	14	75	403	492
District 7					
Cleveland	341	9	85	227	321
District 8					
Cincinnati	207	3	13	249	265
Columbus	127	1	11	109	121
Dayton	120	2	12	100	114
Parkersburg	62		1	23	24
Toledo	91	1	7	77	85
Youngstown	70	1	3	58	62
Charleston	65			81	81
Hamilton-Middletown	59		12	75	87
Lima	47		1	89	90
Lexington, Ky.				57	57
Total	848	8	60	918	986
District 9					
Evansville-Owen.	36		5	48	53
Grand Rapids	26	1	5	27	33
Greater Muskegon	44		10	45	55
Indianapolis	275	5	34	160	199
Muncie	33	1	7	23	31
N. E. Indiana	58	1	9	42	52
So. Bend-Mishawaka	130		12	120	132
Richmond, Ind.	47		5	57	62
Battle Creek-Kal.	36	2	8	44	54
Total	685	10	95	566	671
District 10					
Michigan	434	12	88	396	496
District 11					
Chicago	613	14	103	378	495
District 12					
Central Illinois	40	1	17	25	43
Iowa	151	7	46	103	156
Milwaukee	220	3	74	149	226
Minnesota	202	1	29	179	209
Racine	45		14	27	41
Rockford	51	2	14	33	49
Winnebago	47	1	8	49	58
Kankakee-Joliet	42		3	41	44
St. Charles			3	50	53
Total	792	15	208	656	879
District 13					
Denver	48	1	5	44	50
Kansas City	95		22	71	93
Omaha-Lincoln	48	1	6	35	42
St. Louis	181	7	50	113	170
Wichita	187		19	140	159
Tulsa			1	8	9
Total	559	9	103	411	523
District 14					
Albuquerque	108	1	19	109	129
Baton Rouge-N. O.	44		2	19	21
Dallas-Fort Worth	198	1	36	133	170
Mexico City	51	1		49	50
San Antonio	30		4	29	33
South Texas	95	2	11	79	92
Waco	41		4	26	30
Total	567	5	76	444	525
District 15					
Birmingham	44		3	33	36
Chattanooga	31		6	21	27
Georgia	51	2	12	46	60
Huntsville	25		1	30	31
Louisville	88		11	86	97
Memphis	36		11	28	39
Tennessee	39	2	13	34	49
Pensacola-Mobile			1	8	9
Total	314	4	58	286	348
District 16					
Japan	75		15	61	76
Los Angeles	390	9	99	305	413
Portland	46		3	43	46
Salt Lake City	18	1	2	32	35
San Bernardino	72	1	20	62	83
San Diego	125		46	85	131
San Francisco	154	6	29	180	215
Seattle	80	2	15	68	85
Tucson	19		1	36	37
Phoenix	49		19	42	61
Sacramento	24		4	34	38
Total	1052	19	253	948	1220
International	75	1	6	93	100
Members-in-training					71
GRAND TOTALS	10,497	207	1927	8929	11,134

*Indicates grade of membership: F—Fellow; S—Senior; M—Member.

Appendix B: Report of the Treasurer

During the fiscal year 1957-58, additional progress was made in the refinement of the Society's accounting and bookkeeping procedures. It is expected that with the increased direct collection of dues, these refinements will be effective in providing excellent service in financial transactions with the sections and will provide economy and accuracy in our accounting, auditing, and budgetary controls.

Fiscal Reporting

In cooperation with the Financial Advisory and the Auditing Committees, additional steps have been taken to provide a more simple, effective, year-end financial report. This includes a balance sheet and operating statements which are attached to this report as Exhibits C, D, E, and F.

Budget Conformance

The Milwaukee office is now issuing a monthly budget conformance report for the use of your Officers and the Administrative Secretary. This has provided the information needed to control expenditures and ascertain our financial position on a month-to-month basis. These controls have been used effectively by your Officers and Administrative Secretary.

Financial Advisory Committee

One of the major functions of the Financial Advisory Committee is to administer the Society's securities portfolio. This has been effected in accordance with the suggestions and recommendations of the investment advisory services of the City Bank Farmers Trust Company, the trust affiliate of the First National City Bank of New York, retained specifically for that purpose. During the year the accumulated income was reinvested. No important changes were made in the portfolio.

The committee was very active in working with Society Officers and with the Auditing Committee to implement the indicated modifications in the format of the various reports to present the financial picture of the Society and its various operations. The objectives were conformance to recognized accounting procedures plus increased clarity and interpretation. It is anticipated that this work will continue in 1958-59.

Fort Worth, Texas
June 30, 1958

J. Y. McClure
Treasurer

Exhibit C—Comparative Balance Sheet as of June 30, 1958 and June 30, 1957

ASSETS

	1958		1957	
Current Assets				
Cash on hand:				
For deposit			$ 4,268.00	
Office cash funds	$ 577.67	$ 577.67	590.00	$ 4,858.00
Demand deposits:				
General operations	$19,541.62		$19,755.22	
Convention operations	14,949.73		11,997.08	
Securities operations	1,128.72	35,620.07	1,312.00	33,064.30
Time deposits:				
General operations	$ 1,089.09		$ 940.44	
Brumbaugh Award Fund	2,186.42		2,178.89	
Shewhart Medal Fund	813.58		864.54	
Saddoris Award Fund	30.92	4,120.01	30.14	4,014.01
Accounts receivable:				
General operations	$ 1,760.38		$ 2,762.95	
Convention operations	232.85	1,993.23	144.29	2,907.24
Interest accrued on securities		348.53		391.53
Inventories at nominal amounts:				
Back issues of publications	$ 1.00		$ 1.00	
Stationery and supplies	1.00	2.00	1.00	2.00
TOTAL CURRENT ASSETS		$ 42,661.51		$ 45,237.08
Securities—at cost (quoted market value 1958—$95,692.71; 1957—$92,545.01)				
Fixed Income:				
United States Treasury bonds	$18,372.04		$23,350.48	
Other bonds	22,722.45		25,449.25	
Preferred stocks	11,796.37		10,306.46	
	$52,890.86		$59,106.19	
Equities	39,694.42	92,585.28	30,200.69	89,306.88
Furniture and Equipment—at nominal amount		1.00		1.00
Deferred Charges				
General operations	$ 2,824.79		$ 2,931.89	
Convention operations	500.00	3,324.79		2,931.89
		$138,572.58		$137,476.85

LIABILITIES

	1958		1957	
Current Liabilities				
Accounts payable:				
General operations	$ 5,891.47		$ 5,515.22	
Convention operations	4,732.11	$ 10,623.58	113.72	$ 5,628.94
Accrued salaries		374.35		325.00
Pay roll taxes and taxes withheld from employees		726.17		843.10
Sections dues		6,342.00		5,745.00
Divisions dues		778.00		662.00
TOTAL CURRENT LIABILITIES		$ 18,844.10		$ 13,204.04
Deferred Income				
Dues collected in advance	$14,302.00		$14,472.00	
Library subscriptions unearned	6,400.00		6,960.00	
Advance contributions from sections			766.00	
Exhibit space sales unearned	340.00	21,042.00		22,198.00
Reserves				
For possible losses on securities	$ 5,000.00		$ 5,000.00	
For future conventions			3,500.00	
Brumbaugh Award Fund	2,186.42		2,178.89	
Shewhart Medal Fund	813.58		864.54	
Saddoris Award Fund	30.92	8,030.92	30.14	11,573.57
Net Worth		90,655.56		90,501.24
		$138,572.58		$137,476.85

NOTE A—As of July 1, 1957, the Society changed from a cash basis to an accrual basis of accounting. The effect of this change was to decrease net worth by $8,587.91 at July 1, 1957, and to credit operations with a corresponding amount for the current year

Exhibit D—Changes in Net Worth and Reserves, Year Ended June 30, 1958

	Net Worth				Reserves				
	General Operations	Convention Operations	Securities Operations	Total	For Possible Losses on Securities	For Future Conventions	Brumbaugh Award Fund	Shewhart Medal Fund	Saddoris Award Fund
Balance at July 1, 1957	$ 4,973.19	$ 8,497.08	$85,618.88	$ 99,089.15	$5,000.00	$3,500.00	$2,178.89	$864.54	$30.14
Deduct adjustment to reflect change to accrual basis of accounting (additions*)	9,010.01	30.57*	391.53*	8,587.91					
ADJUSTED BALANCE AT JULY 1, 1957	($ 4,036.82)	$ 8,527.65	$86,010.41	$ 90,501.24	$5,000.00	$3,500.00	$2,178.89	$864.54	$30.14
Add:									
Excess of income over expense		6,582.82	3,052.12	9,634.94			7.53		.78
Transfer from Convention Operations	8,000.00			8,000.00					
Transfer from Reserve for Future Conventions		3,500.00		3,500.00					
	$ 3,963.18	$18,610.47	$89,062.53	$111,636.18	$5,000.00	$3,500.00	$2,186.42	$864.54	$30.92
Deduct:									
Excess of expense over income	$12,980.62			$ 12,980.62				$ 50.96	
Transfer to General Operations		$ 8,000.00		8,000.00					
Transfer to Convention Operations						$3,500.00			
	$12,980.62	$ 8,000.00		$ 20,980.62		$3,500.00		$ 50.96	
BALANCE AT JUNE 30, 1958	($ 9,017.44)	$10,610.47	$89,062.53	$ 90,655.56	$5,000.00	$ -0-	$2,186.42	$813.58	$30.92

( ) Indicates deficiency in assets. See note to balance sheet.

Exhibit E—Statement of Income and Expenses, Year Ended June 30, 1958

General Operations:		
Income:		
Membership dues	$67,531.65	
Publications	51,150.73	
Contributions	13,119.34	
Miscellaneous	3,260.13	$135,061.85
Expense:		
Publications:		
Printing, mailing, and engraving costs	$51,307.13	
Salaries	19,884.41	
Advertising	5,734.24	
Office supplies and expense	1,253.58	
Travel expense	942.72	
Sundry	105.28	
	$79,227.36	
Executive group expenses	$ 1,176.37	
Executive secretary:		
Salaries	$30,727.80	
Pay roll taxes	798.10	
Blue Cross insurance	341.25	
Rent	3,906.18	
Travel and promotion	3,352.02	
Equipment and equipment maintenance	446.80	
Office supplies and expense	1,943.38	
Postage and express	2,570.65	
Telephone and telegraph	1,360.06	
Record maintenance	4,913.50	
Services to sections and divisions	2,099.93	
Certificates and pins	1,328.21	
Printing and duplicating	1,029.67	
Dues, bills, and membership cards	1,794.87	
Membership brochure and application blanks	1,283.10	
Ballots and annual meeting notice	1,250.23	
Section and committee manuals	344.00	
	$59,489.75	
Treasurer:		
Salaries	$ 5,552.40	
Legal and other professional	1,505.00	
Insurance	897.61	
Collection, exchange, and bank fees	193.98	
	$ 8,148.99	148,042.47
EXCESS OF EXPENSE OVER INCOME—GENERAL OPERATIONS		$ 12,980.62
Convention Operations:		
Income:		
Registration fees	$26,162.00	
Exhibit booth sales	12,060.00	
Transactions sales	1,402.05	
Miscellaneous	2,911.26	$ 42,535.31
Expense:		
Luncheons and banquet	$12,069.90	
Publicity and promotion	5,557.57	
Technical program	4,648.91	
Exhibit expense	6,388.00	
Transactions	3,642.25	
Social program	2,358.41	
Miscellaneous	1,287.45	35,952.49
EXCESS OF INCOME OVER EXPENSE—CONVENTION OPERATIONS		$ 6,582.82
Securities Operations:		
Income:		
Interest earned	$ 1,520.12	
Dividends received	1,873.72	
Gain on sale of securities	118.20	3,512.04
Expense—investment advisory service		459.92
EXCESS OF INCOME OVER EXPENSE—SECURITIES OPERATIONS		$ 3,052.12
EXCESS OF EXPENSE OVER INCOME—COMBINED OPERATIONS		$ 3,345.68

See note to balance sheet.

Quality Control Engineer

To work in progressive quality-control engineering department. Requires a minimum of two years' work experience in the mass production of small parts—preferably including at least one year of *Q. C. engineering* work or the equivalent in training.

The job includes: Capability studies. Setting up and running experiments. Designing process-control systems and devising methods of measurement.

Please state salary requirement.

Send resume to:

W. S. Hertzmark
Raytheon Manufacturing Company
Receiving Tube Division
55 Chapel Street
Newton, Massachusetts

RAYTHEON

Excellence in Electronics

quality engineer

This challenging position, with one of the country's most progressive manufacturers, could be the most important step in your career. It affords the opportunity to plan and initiate complete quality control programs for new products and processes from design to production.

We are looking for a man 25 to 35 with a degree in engineering and heavy math training who has had at least five years experience in quality control methods and applications in a precision industry.

Reply by letter to Employment Manager, stating age, education, experience, and salary requirements.

Argus Cameras
Ann Arbor, Michigan

Exhibit F—Statements of Income and Expense—Award Funds, Year Ended June 30, 1958

Brumbaugh Award Fund

Income—interest earned	$57.53
Expense—cash award to C. R. Hicks	50.00
EXCESS OF INCOME OVER EXPENSE	$ 7.53

Shewhart Medal Fund

Income—interest earned	$22.82
Expense—cost of medals	73.78
EXCESS OF EXPENSE OVER INCOME	$50.96

Saddoris Award Fund

Income—interest earned	$ .78

See note to balance sheet.

Certificate of Audit

Auditing Committee
American Society for Quality Control, Inc.
161 West Wisconsin Avenue
Milwaukee 3, Wisconsin

We have examined the financial statements of American Society for Quality Control, Inc. for the year ended June 30, 1958. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying balance sheet and statements of income and expense and changes in reserves and net worth present fairly the financial position of American Society for Quality Control, Inc. at June 30, 1958, and the results of its operations for the year then ended, in conformity with generally accepted accounting principles.

Milwaukee, Wisconsin
August 8, 1958

Ernst & Ernst
Certified Public Accountants

Certificate of Auditing Committee

Ernst & Ernst, Certified Public Accountants, were retained to audit the books of the American Society for Quality Control, Inc. Relying on this audit and the certificate of Ernst & Ernst, we are of the opinion that the accompanying Balance Sheets, Statements of Income and Expense, and Changes in Reserves and Net Worth fairly present the financial position of the Society as of June 30, 1958 and its financial transactions for the fiscal year ending that date.

Auditing Committee

Howard R. Bolton	Paul A. Robert
Walter W. Merrill	George Thompson
Blair Olmstead	G. Rupert Gause, *Chairman*

Appendix C: Report of the Editorial Board

Purpose of the Board

It is the function of the Editorial Board to have operating supervision of *Industrial Quality Control* and all other technical publications of the Society.

Advertising

A review of the advertising support for Volume XIV will be found in the report of Henry J. Becker, Vice President.

Data on Volume XIV

This volume consisted of 512 pages plus 48 cover pages. Of the 512 pages available for editorial copy, 421, or about 82 percent were used for this purpose, the remaining 18 percent were paid ads. Of the 48 cover pages, 28 were for paid ads, 12 for front covers, 6 for ASQC publicity, 2 unused.

Issue No. 5 (November 1957) carried the ASQC Standard A2-1957: Definitions and Symbols for Acceptance Sampling by Attributes.

In Vol. XIV, a total of 51 contributed papers were published, averaging 3.8 pages per paper and ranging from a little under one page to 7.5 pages in length. Percentagewise, these 512 pages were distributed as follows:

Contributed papers	37.6%
Section Briefs	11.0%
Departmental Copy	15.9%
Paid ads	18.0%
Miscellaneous (Masthead and Contents pages, editorials, ASQC Convention Publicity, Stock Lists, Annual Reports, etc.)	17.5%
	100.0%

Contributed papers can be classified as follows:

General Applications of SQC Methods	10
Special Applications of SQC Methods	19
General Interest	17
Technical	5

Reprints

During Vol. XIV, 58 orders for reprints of articles published in *Industrial Quality Control* were processed; quantities ordered ranged from a modal value of 100 up to two orders for 1,000 and one for 2,000 copies.

Requests for permission to reprint privately items from *Industrial Quality Control* and other publications on which ASQC holds copyright totaled 72 in the period July 1, 1957-June 30, 1958. Two of these requests were rejected; 70 approved.

General Publications

In April 1958, the Society published "The Power to Detect a Single Slippage and the Probability of a Type One Error for the Upper 3σ Limit Control Chart for Fraction Defective" by Dr. Edwin G. Olds, approved by the Editorial Board for issuance as General Publication No. 4.

Editorial Board

The following persons have accepted appointment to the Editorial Board for a five-year term beginning July 1, 1958:

Harold F. Dodge, Bell Telephone Laboratories (Retired)
Howard L. Jones, University of Chicago
Mary N. Torrey, Bell Telephone Laboratories

The three men retiring from the Board as of June 30, 1958 are:

A. J. Duncan, Johns Hopkins University
William R. Pabst, Navy Department, Bureau of Ordnance
Paul Olmstead, Bell Telephone Laboratories

Carl E. Noble, Kimberly-Clark Corp. will replace Edgar P. King, Eli Lilly & Company, who asked to be relieved of Editorial Board responsibilities as of June 30, 1958.

Acknowledgments

Grateful acknowledgment is due the following persons for editorial assistance in reviewing submitted manuscripts in cooperation with the Editorial Board:

Leo A. Aroian	Gayle W. McElrath
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Robert W. Kennard	Leonard A. Seder
Walter P. Koechel	Mary N. Torrey
Donald S. Leckie	John W. Tukey

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Bibliography	Joe Movshin
Book Review	W. D. Baten
Management's Corner	J. M. Juran
Practical Aids	E. R. Ott
Problems Department	P. C. Clifford and T. A. Budne
Section Briefs	G. R. Foster
Supervisor's Circle	P. A. Robert
What's New?	R. A. Wylie

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What's New?

ROY A. WYLIE, *Editor*

When inquiring about "What's New?" items, please mention INDUSTRIAL QUALITY CONTROL

Wayne Kerr Instruments, P.O. Box #801, Philadelphia 5, Pa. announces the availability of a new Component Bridge, Type B-521, employing the transformer ratio arm principle, designed to provide accurate direct measurement over an extremely wide range of resistance, capacitance and inductance. The B-521 bridge is a true impedance bridge, separately indicating the resistive and reactive components of the impedance. Also, impedance measurements in circuit are easily accomplished. The bridge is self-contained, with an effective ratio of 10^{12}:1, providing a range of measurement impossible to achieve with conventional bridges. A rearrangement of the test leads enables a wide range of four-terminal measurements to be made, including that of low impedances down to 0.001 ohms. The bridge measures capacitance from 1 uuF to 5 F, inductance from 1 uH to 5,000,000 H, and resistance from 0.001 ohms to 1,000 megohms in ten ranges. Two continuously variable controls indicate independently the reactive and resistive terms of the impedances measured. The following examples indicate the scope of measurements possible with this instrument: dry joints, high capacitance electrolytics with or without D.C., insulation resistance, switch contact resistance, inductors with D.C., effectiveness of transformer screens, ground bonding efficiency, etc.

New Literature Available

A brochure entitled 'New Horizons for Supervision" has been published by Elliott Service Co., Inc., 30 No. MacQuesten Parkway, Mount Vernon, N. Y. The brochure is offered free of charge to interested persons. The brochure outlines a program of management information designed to make payroll dollars more productive through improved supervision. Subjects covered are cost and waste control, human relations, employee training, accident prevention, quality and service, methods improvement, effective communication, basic business principles, actual case studies, weekly memo on current industrial and business news.

Copies of American Standard B27.2-1958 (Plain Washers) are now available at $1.00 per copy from the American Standards Association, 70 East 45th St., New York 17, N. Y. or from the American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.

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sections briefs

ALLENTOWN-BETHLEHEM . . . At the Aug. 13 executive committee meeting, many interesting items were discussed and the budget for fiscal 1958-59 was presented and approved. Bob Sehin enlightened all present with the aims and plans of the special committee on professional development. Ken Stevens and Irv Yeager discussed the status of this year's educational program; text books are completed and instructors have been obtained. Course #9 will be presented simultaneously in Allentown and Reading. John Nemecek briefly discussed the plans for the coming all-day conference in Allentown.

The annual summer outing turned out to be a very enjoyable event for everyone—kids from 6 to 60 especially. The food was excellent, the games were fun, and the cloudburst held out until the scheduled closing time. Carl Furler and his intrepid band of circus barkers kept things moving at a lively clip.

BALTIMORE . . . A meeting of the section officers was held on Aug. 19 at the Johns Hopkins University to review the progress being made in formulating the 1958-59 program. Considerable progress has been made by program chairman Frank J. Cullen in obtaining speakers for our monthly meetings. It was agreed to eliminate the February meeting to enable the section to contribute to the Engineers' Week occurring in February.

The agenda for the pre-meeting basic QC training sessions was discussed. The agenda covers the instruction of basic statistical concepts by those employed in private industry, government, and in education here in Baltimore. There are seven sessions planned which are intended for individuals new to the field of QC and to those who require a refresher course.

BATTLE CREEK-KALAMAZOO . . . Section chairman Wm. Shideler recently appointed the following committee chairmen: membership—Philip Harris, Aircraft Div., Eaton Mfg. Co.; program—Deland Davis, Post Cereals; Saddoris Award—Prof. A. E. Wylie, Michigan State University; and education—Dr. W. D. Baten, Michigan State University.

BOSTON . . . An executive board meeting was held on Aug. 6 and plans for the social evening and annual outing during the 1958-59 season were discussed.

In the line of business, A. Costello of the Keystone Mfg. Co. was appointed as delegate to the New England Conference which will be held in Pittsfield on Oct. 29-31.

The education committee presented a questionnaire to the board which is intended to reach the membership and thereby learn their needs and desires regarding lectures and speakers. The board approved and applauded this move and are confident that it will result in a more effective, interested, and informed membership.

BUFFALO . . . The section established awards to be given to two students at the University of Buffalo who have demonstrated interest and special aptitute in applied statistics. The awards are a year's membership in ASQC. This year's awards went to Edward J. Ridler, School of Engineering, and Edwin Silverburg, School of Business Administration.

CHARLESTON . . . The theme of the November meeting will be "management night." Executives from local industries will be treated to dinner, displays, and a chance to hear a well known QC personage. A great turnout is expected.

CHICAGO . . . A series of lectures is being conducted at the University of Illinois, Navy Pier, Room 65. Using a new and different teaching technique, these lectures depict the application of quality control principles when the going is rough and when the going is smooth. The course, sponsored under the advanced educational program of the section, will continue every Wednesday for approximately 16 weeks. Each class consists of a lecture and a laboratory session. The new teaching approach has been named Peg-Board statistics, the meaning of which will be explained during the course. Arrangements can be made by calling Mae Goodwin Tarver (VI. 6-7000, ext. 450—Chicago telephone).

CLEVELAND . . . At the Aug. 6 meeting, the executive committee voted not to hold the annual one-day conference this fall. The approaching 13th Annual ASQC Convention to be held in Cleveland this spring and general economic conditions were the main reasons for the committee's decision.

The first plant trip of the year will be held on Nov. 7 when the section will visit The Sohio Research Laboratories. Richard Shaw promises a most interesting trip.

CORNING-ELMIRA . . . The education committee has been actively planning a program which will include courses in life testing and process capabilities. One of the courses will be offered in late October and the other in spring. Dr. John Kao of Cornell University will instruct the classes in life testing.

CUMBERLAND . . . Newly elected officers for 1958-59 are: president—G. H. Fisk, Celanese Corporation of America; vice president—L. B. Martins, Celanese Corporation of America; and secretary-treasurer—T. E. Kight, W. Va. Pulp and Paper Co.

DALLAS-FORT WORTH . . . The Aug. 23 family outing at the Briggs-Weaver Lodge on Grapevine Lake was enjoyed by 40 members and 21 guests. A marvelous barbecue dinner was served by a local catering firm. Most of those attending made a second trip through the "chow-line" and some even made thirds. While lounging and enjoying cooling refreshments were the general order of the day, the more vigorous of the group, especially the children, pitched washers or horse shoes, played croquet or badminton, went swimming, water skiing, or just boat riding.

Dorian Shainin, Rath & Strong, Inc. of Boston, will speak at the regular monthly meeting on Thursday, Nov. 13. The subject of his talk will be "How managements have drastically reduced operating costs." We welcome Mr. Shainin back for a return visit and all of our members will want to make a special effort to attend.

The August issue of "Industrial Quality Control" carried a very fine synopsis of our program honoring J. Y. McClure and at which we were honored to have L. S. Eichelberger, executive secretary of the Society, as a guest. Both the fine write-up and Mr. Eichelberger's presence were appreciated by the section.

DAYTON . . . New section officers are: chairman, James M. Cogar, Chrysler Airtemp; vice chairman, William L. Colello, Aeroproducts Operations, GMC; secretary, John M. Stanch, Leland Electric Co.; and treasurer, Robert C. Stockert, Delco Products Div., GMC.

DELAWARE . . . The program this year has been planned so that most major areas of QC and related subjects are covered. The regular after-dinner meeting is reserved for broad aspects of QC with the emphasis on applications. Techniques and case histories will be covered in clinic sessions of one hour each prior to dinner. This program is planned for all levels each night. We are confident that everyone attending will learn something about a new technique, a new twist to an old technique, or something about related fields.

Some of the areas to be covered will be market testing, management, sales forecasting, and work sampling. We are also very fortunate to have some of the best qualified men in the field to discuss these subjects.

At the Nov. 6 meeting, Henry Brenner, president of the Home Testing Institute, will discuss quality control and market research. Clement Bason, International Latex Corp., will speak at the clinic session. He will discuss various sampling plans available, OC curves, and inspection costs. The sampling plans will cover various defect levels.

DENVER . . . The first meeting to open the 1958-59 season was held in September when the section toured the plant facilities of the Gates Rubber Co.

At the second meeting of the year, the subject of "sonic testing" was thoroughly discussed.

The officers for 1958-59 are: chairman—J. A. Schulz, The Dow Chemical Co.; vice chairman—W. Ardner, Sundstrand Turbo Co.; secretary—R. McConnell, Sundstrand Turbo Co.; and treasurer—J. Clark, Robinson Brick and Tile Co.

EVANSVILLE-OWENSBORO . . . Dorian Shainin, director of statistical engineering for Rath & Strong, Inc., will be the speaker for the Nov. 18 meeting to be held in Owensboro. Mr. Shainin's subject will be "Controlling the quality of management's decisions."

ERIE . . . The first meeting of the 1958-59 year was held on Sept. 24 at Niesen's Restaurant. Before dinner, R. Herrick of Erie Resistor led a discussion on a case problem related

to a mass production type of operation. After dinner, P. Green of the General Electric Erie Foundry gave a talk on "Quality control in a non-ferrous foundry."

GREATER MUSKEGON . . . The executive committee met at Stern's Steak House on Aug. 18. Program chairman Lawrence Long reported the year's program was complete. Two out-of-town meetings are to be held due to the wide distribution of members in Muskegon, Kent, and Ottawa counties. Membership chairman Mike Pascavis stated that the year's program, application form, and a covering letter were in the mail to firms in Muskegon, Whitehall, Montague, Grand Haven, and Holland. A workshop-type training course was briefly discussed.

The Nov. 13 meeting will be a joint meeting with representatives from the American Society of Tool Engineers and the Muskegon Manufacturers Association. The DoALL Company of Des Plaines, Ill., manufacturers of all types of cutting tools, will present their instructive program. A highly attended meeting is anticipated.

HAMILTON . . . At an executive meeting on Aug. 20, W. C. Luton was elected to the position of chairman. Our new vice chairman is George Homewood and the new secretary is F. W. Vallely. These executive changes were brought about owing to the death of chairman Al Mitchell.

With representatives from the University of Western Ontario and St. Catharines sections present, initial arrangements were drawn up for the jointly sponsored "quality control clinic" which will be held at Fischer's Hotel during the afternoon and evening of Nov. 13. With Charles A. Bicking, Simon Collier, and B. H. Lloyd already confirmed as speakers, a fine start has been made towards making this year's clinic a memorable one.

HARRISBURG . . . The section held its final executive committee meeting at RCA in Lancaster on Aug. 27. Final plans were made and many new and interesting speakers have been scheduled.

The education committee this year has arranged to present a comprehensive basic course in college level SQC to be followed in succeeding years by an intermediate and an advanced course. We are fortunate to have James T. Skelton, superintendent of inspection for Caterpillar Tractor Co., as course instructor. The possibility of issuing credits for these courses is being checked.

The Nov. 5 meeting will be a "buzz session" on quality control policy problems. The two questions which will be discussed by the speaker and members attending are: (1) Should an inspector have authority to shut down a machine or stop a process, and (2) Should material that does not conform to specifications be used in production? James T. Skelton, ASQC director, will be the discussion leader and following group discussions will make a final summary of the viewpoints and results. The meeting place will be the Moose Lodge.

HARTFORD . . . Members and their guests are being offered the opportunity to become familiar with the latest in measuring and inspection apparatus. Representatives of two different manufacturers will be present at each monthly meeting to present displays, conduct demonstrations, and answer questions. They will be available before dinner, during the break between dinner and the meeting, and then again after the meeting.

INDIANAPOLIS . . . The kick-off meeting consisted of a plant tour of the Cummins Engine Co. at Columbus. A very interesting talk on "Quality control—a personal view" was presented by W. B. Rowe, superintendent of production at Cummins.

Plans are now being formulated for the 14th Midwest QC Conference to be held at French Lick, Ind. Prof. C. Hicks of Purdue University is program chairman. This conference is too big for two days; hence it will require three full days to cover the material as outlined. There will be both technical sessions and sessions on the management level. Watch the Indianapolis section news for details as they develop.

LIMA . . . Guests for the September meeting were office managers of the area who heard Wm. Buhl of the Goodrich Tire Co. talk on "QC in offices." The object here was to show the potential application of SQC. In addition, all officers and committee chairmen were introduced. An invitation was extended to the membership to join the committee of their choice.

The section has developed this year's educational program under the leadership of educational chairman Gordon Robertson and co-chairman Ray Decker. A basic course and a course in gaging will be given this fall; applied problems in QC and a course in acceptance sampling will be offered after the first of the year.

LOUISVILLE . . . The first meeting of the 1958-59 season took place at the Speed School on Sept. 9 with 28 members present. Edward Schrock of American Radiator and Standard Sanitary Corp. presented "Quality cycle correlations and interactions" or "What makes the quality pendulum swing?" Mr. Schrock gave a very informative discourse on this subject, pointing out that we should not jump to conclusions in the analysis of various problems dealing with quality.

The education committee reported that basic, intermediate, and advance courses in QC will again be held this fall and next spring. The dates are to be announced soon.

Regular meetings for 1958-59 will be held at the Speed School Auditorium on the second Tuesday of each month and will start at 8:15 pm.

METROPOLITAN . . . An unusual and exciting program is planned for Nov. 13 when the section will meet at the Bristol-Myers Products Division plant at Hillside, N. J. The evening program will begin at 6 with a guided tour of the plant. Here the members and their wives will have the opportunity to witness the manufacturing, filling, and packaging of the many Bristol-Myers' drug and cosmetic products. The company's various applications of SQC will be of particular interest to the members and the high-speed automatic filling and packaging equipment will have immense appeal for the ladies.

After the tour, the group will convene for a 7 pm dinner in the company cafeteria. A formal meeting will then be held in the Bristol-Myers' auditorium. O. E. Johnson, vice president in charge of production, will be the principal speaker. Other talks on QC topics of general interest will follow.

MID-HUDSON . . . The executive committee met on Aug. 26 in the QC office of the Poughkeepsie IBM plant. Chairman Frank J. Sindelar discussed plans for the new season and individual committees gave reports on their activities.

The Nov. 11 meeting will feature a plant tour of the Western Printing & Lithographing Co., Poughkeepsie. The tour will begin at 8 pm.

MONTREAL . . . An executive meeting was held on Aug. 12 in the office of the chairman to finalize and approve plans for the 1958-59 season. The section will again sponsor an

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PROGRAM HIGHLIGHTS

Reliability

what can be done to improve . . . through maintenance . . . with environmental laboratory aid . . . through accuracy of measurement . . . "q" reports . . . data feedback . . . contamination control . . . in missile program . . . reliability panel . . . evaluation problems at test center

Quality Control

in repair, overhaul and modification . . . in nuclear facility . . . from cockpit . . . af engineering program . . . effects on af and usn combat readiness . . . knowledge of . . . after facts

Weapon Systems

electronics and quality control in . . . q.c. task in . . . practical engineering techniques for improving

Costs

control through work measurement . . . reduced testing through statistics . . . multiple sampling method . . . purchased material vs. purchase order

Suppliers

panel . . . communicating requirements to . . . source inspection vs. evidence furnished . . . responsibility for proprietary products . . . new government regulations

Contributed Papers

For complete program or other information write to:

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evening course in "QC by statistical methods" under the chairmanship of Prof. Roger Lessard of the Ecole Polytechnique, Montreal. The fall term will cover "process control."

A joint meeting with the Canadian Aeronautical Institute will be held on Oct. 29. R. M. Jacobs of the Radio Corporation of America, New Jersey, will be guest speaker.

On Nov. 19 a joint dinner meeting with the Montreal group of the American Society of Metals will be held. The speaker for the evening will be Henry G. Becker of the American Steel and Wire Div., U. S. Steel Corp., Illinois.

MUNCIE . . . August was a busy month for the executive committee! Plans were completed for the training course which began Sept. 9; a management night program was arranged to open the season with a talk on "Total quality control" by S. A. Yingling of General Electric; arrangements were made with the Marion installation of RCA for a tour of their plant; speakers were slated for the season up through May; programs printed; stationery purchased; and a thousand other details taken care of. All this work took place in August—that's the period of "inactivity"!

Thursday night, Nov. 20, will mark a very special program. Jack Gantt of General Electric's Cincinnati plant will address our regular 7:30 meeting at the Student Center. Dinner will be served at 6:30. Graduates of the training course will be special guests and each will receive an award of merit signifying successful completion of the course.

NEW HAVEN . . . On Aug. 12 the second meeting of the executive committee was held at which time the program for the year was approved.

The Nov. 11 meeting will be a plant tour of the Armstrong Rubber Co., West Haven. The tour will be conducted by Mr. Palmieri and should be very interesting to those who have never seen rubber products manufactured.

PITTSBURGH . . . On Aug. 19 the officers and new executive committee met and the various committee chairmen were officially installed. They are: advisory, Edwin G. Olds; education, Frank Caplan, Jr.; membership, George Shombert, Jr.; nominating, Frank G. Norris; publicity, George C. Lecky; Saddoris award, William I. Martin; and special projects; Philip E. Schneider.

The program for the coming year was approved by all present along with a change in meeting place to the Downtown YMCA at Wood Street. A lively discussion developed on methods of getting members to attend meetings this coming year. It was suggested and voted that a method of telephone calls be used whereby all members would be contacted a day or so prior to each meeting.

PORTLAND . . . The executive committee received a letter from the Society's headquarters office concerning the Oregon Centennial. The reasons cited for declining assistance were considered well founded and will be relayed to all members at the next scheduled meeting. It is hoped that the section will still have representation. This may be accomplished by each member being sponsored by the company he represents.

The recent joint meeting with the Institute of Food Technologists was a great success. The discussion on "The basic philosophy of quality control" was well conducted. Plans are now being made for the section to act as host for IFT at a future date.

A course in SQC is being taught at Portland State Extension Center. It is organized primarily for those who are now engaged in SQC work, or those who see applications for QC but lack the necessary background for its effective use. It was instituted through the efforts of the section.

The Nov. 4 meeting is expected to be very educational. Those members and guests who attend the meeting will be able to voice their opinions and possibly obtain converts.

ROCHESTER . . . The gaging and measurement sub-group will hear a speaker from Link Aviation discuss "Interferometric measurement" at their Nov. 4 meeting.

On Nov. 18 our good friend Warren R. Purcell will answer the question "Who controls quality—and how?"

ST. LOUIS . . . The section, in conjunction with the Metropolitan St. Louis Chamber of Commerce (Industrial Division), is conducting courses in basic and advanced SQC. Courses will run for ten weeks and will be presented simultaneously to separate groups on Thursday evenings.

The section again is sponsoring the annual St. Louis conference. The speakers are: "Total quality control," A. V. Feigenbaum, General Electric Co.; "Non-parametric statistics," E. C. Harrington, Monsanto Chemical Co.; "Design of

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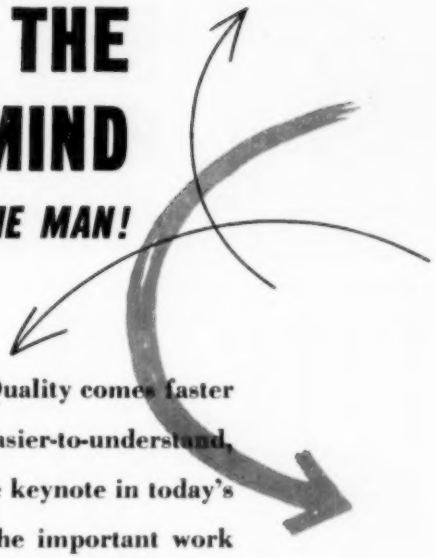

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SECTION CALENDAR (OCTOBER 25–NOVEMBER 30)

SECTION	DATE	PLACE	TIME	SUBJECT	SPEAKER
Allentown-Bethlehem	Nov. 12	Hotel Traylor	8:00 pm	Practical Application of Sampling Plans Tolerance Problems	J. V. Markley, Western Electric Co. Sutton Monroe, Bell Telephone Labs, Inc.
Baltimore	Nov. 18	Baltimore Memorial Stadium	8:15	———	———
Battle Creek-Kalamazoo	Nov. 17	American Legion Clubhouse, Battle Creek	7:00	Quality Control and the Tool Engineer (Joint ASTE-ASQC Meeting)	———
Boston	Nov. 13	M.I.T. Faculty Club	8:00	Quality Control of Visual Characteristics	William Carter, Rath & Strong, Inc.
Buffalo	Oct. 27	Boots & Saddle Restaurant, Niagara Falls	6:30	The Basis for Interpreting Results from a Testing Process	Dr. Grant Wernimont, Eastman Kodak Co.
Buzzards Bay	Nov. 13 Nov. 24	Continental Screw Co. Continental Inn, Tonawanda	8:00 6:30	——— Benefits of QC as Seen by Production Management	Leonard Caplan, U. S. Time Corp. John W. Tully
Cleveland	Nov. 7	———	3:30	Plant Trip—Sohio Research Laboratories	———
Columbus	Nov. 19	Timken Roller Bearing Co.	8:00	How Can QC Contribute to Manufacturing	Panel Discussion
Corning-Elmira	Nov. 18	Baron Steuben Hotel, Corning	8:00	Life Testing: Statistical and Practical Problems	George Levenbach, Bell Telephone Labs, Inc.
Cumberland	Nov. 6	———	6:30	Quality—A Team Effort	J. R. Gilman
Dallas-Fort Worth	Nov. 13	Arlington State College	8:00	How Management Has Drastically Reduced Operating Costs	Dorian Shainin, Rath & Strong, Inc.
Dayton	Nov. 6	Moraine Products Div., GMC	8:00	QC in Production of Aluminum Foil	G. H. Bishop, Reynolds Metals
Delaware	Nov. 6	Lord DeLaWarr Hotel, Wilmington	8:00	Establishment of QC Standards Through the Use of Market Research	Henry Brenner, Home Testing Institute
Erie	Nov. 19	Meadville	6:30	Case Problem, Formal Presentation	———
Evansville-Owensboro	Nov. 18	Owensboro	7:30	Controlling the Quality of Management Decisions	Dorian Shainin, Rath & Strong, Inc.
Greater Muskegon	Nov. 13	Doo Drop Inn	6:30	The Story of the Cutting Edge	DoALL Company presentation
Hamilton	Nov. 13	Fischer's Hotel	———	Quality Control Clinic	Charles A. Bicking, Simon Collier, B. H. Lloyd
Harrisburg	Nov. 5	Moose Lodge	6:30	Buzz Session on QC Policy Problems	James T. Skelton, Caterpillar Tractor Co.
Hartford	Nov. 4 Nov. 18	Club Alden Club Alden	6:30 6:30	Executive Committee Dinner Meeting	——— ———
Louisville	Nov. 10	Speed School	8:15	Economy in Experimental Design	John Thornby
Metropolitan	Nov. 13	Bristol-Myers Products Div., Hillside	6:00	Plant Tour	O. E. Johnson, Bristol-Myers Products Div.
Mid-Hudson	Nov. 11	Western Printing & Litho, Poughkeepsie	8:00	Plant Tour	Wm. M. Cranston, Western Printing & Lithographing Co.
Montreal	Oct. 25	Ecole Polytechnique	———	Solving Industrial Problems Through Better QC (2nd All-Day Forum)	———
	Oct. 29	C.I.L. Bldg.	8:00	———	R. M. Jacobs, RCA
	Nov. 19	———	6:30	Dinner Meeting	H. J. Becker, American Steel & Wire Div., U. S. Steel Corp.
Muncie	Nov. 20	Student Center	6:30	Quality	Jack S. Gantt, General Electric Co.
New Haven	Nov. 11	Armstrong Rubber Co., West Haven	8:00	Plant Tour	Joseph Palmieri, Armstrong Rubber Co.
Omaha-Lincoln	Nov. 14	Lincoln	7:00	Development of Piloted Aircraft and Guided Missiles	Dr. Robert Lusser, Redstone Arsenal
Pittsburgh	Nov. 25	YMCA, Wood St.	8:00	Basic Quality Control	Julian H. Toulouse, Owens-Illinois Glass Co.
Portland	Nov. 4		7:30	What is Quality Control?	———
Rochester	Nov. 4 Nov. 18	Chamber of Commerce Chamber of Commerce	6:15 6:15	Interferometric Measurement Who Controls Quality—and How?	——— Warren R. Purcell, Raytheon Mfg. Co.
St. Louis	Nov. 14	Golden Fried Chicken Loaf Restaurant	6:30	Administrative Applications of SQC	Dr. Carl E. Noble, Kimberly-Clark Corp.
San Antonio	Nov. 11	Hilton Hotel	7:30	How Management Has Drastically Reduced Operating Costs	Dorian Shainin, Rath & Strong, Inc.
Syracuse	Oct. 28	Turn Hall	6:30	Simple Techniques for Adjusting Production Plans by Sales Trends	E. H. Robinson, Johnson and Johnson
	Nov. 25	Turn Hall	6:30	———	James L. Harris, Standard Pressed Steel Co.
Toledo	Nov. 3	Angelo's	6:30	Quality Control—Management's Standpoint	M. R. Lynn and W. E. Barker, General Electric Co.
Toronto	Nov. 12 Nov. 26	University of Toronto Sign of the Steer	8:00 6:30	QC in the Chemical Industries RCAF QC Requirements for the Avro "Arrow"	Charles A. Bicking, The Carborundum Co. Wing Commander G. Waterman, RCAF
Winnebago	Nov. 10	Elk's Club, Appleton	6:30	———	———
Univ. of W. Ontario	Nov. 13	Hamilton	3:00	Quality Control Forum	Charles A. Bicking, Dr. Brant Bonner, Simon Collier, and B. H. Lloyd

experiment and analysis of variance," Bessie B. Day and Frank R. Del Priore, Bureau of Ships, Department of the Navy; and "Quality control in the field of missiles," Donald E. Hartvigsen, Aerojet-General Corp.

SAN ANTONIO . . . The executive committee met during the month of August to discuss the affairs of the section and to put the final touches on the "loose ends" of the coming season's program. We are happy to announce, as are the other Texas sections, that through the combined efforts of the program chairmen, eight prominent speakers have made commitments to make "circuit tours" to the Texas sections. Our season program sheet has been distributed to the membership announcing meeting dates, time, place, speaker, and subject.

The coming year's program is indeed an impressive one. Several of the highlights include a basic SQC course for members and two plant tours and a Xmas party for members and their families.

Initial plans have been made concerning a one-day symposium to be held in early 1960. Earl Doiron has been appointed general chairman for this event.

SAN FRANCISCO BAY AREA . . . The first meeting held Aug. 11 featured a tour of the San Francisco base of Pan American World Airways. Following a very fine dinner, the maintenance facilities were toured and a film "All around the world" was shown. The film and the tour gave us an insight on the complexity of the air transportation business.

In addition to approximately 60 members and guests we were honored with the presence of several Society dignitaries—C. E. Fisher, president; J. Y. McClure, vice president; and Wm. P. Youngelaus, Jr., administrative secretary.

SOUTHERN CONNECTICUT . . . The executive committee held their August meeting at the beautiful Hampshire Country Club in Mamaroneck, N. Y. They were the guests of Sidney Wolberg and Marvin Lee of the Burndy Corp. Mr. Wolberg is director of foreign operations and Mr. Lee is executive vice president. The program planning for the coming season was completed by the committee.

The theme of this year's program is the purpose of SQC in industry, starting with its fundamental role in manufacturing and ending with its use in research. The programs will be designed to promote interest among the newcomers and to provide additional information to the regulars.

TENNESSEE . . . On Aug. 1 a new professional organization, the Institute of Nuclear Materials Management, was formed. The leaders in the nuclear materials management field were extended invitations to join this new organization as initial members. Two section members, Robert G. McMillan and Ronald D. Smith, were extended invitations. Congratulations!

New members of the program committee for this year are Pete Littleton, Howard Lovelass, and Dave Chambers. Alan Lasater is handling membership renewals this year.

TULSA . . . The executive committee has been meeting every two weeks during the summer to help get our new section off to a flying start. The arrangements have been completed and the announcements mailed for our first educational program. The meetings will be held at the Alvin Hotel, and an invitation is extended to all members of the Society to attend our meetings. Most of the speakers have been confirmed for our all-day anniversary forum scheduled for Apr. 4, 1959.

We want to express our sincere thanks to Midwestern Instruments and to Don Hagerman for assistance in printing our educational program announcements.

The section has been asked and will participate in a special engineering registration booth to be operated by all technical societies in the area at the International Petroleum Exposition scheduled for next May 14-23, 1959.

WINNEBAGO . . . The September meeting was held at the Elk's Club in Appleton. The speaker for the evening was Dale A. Cue, assistant director for quality control, A. O. Smith Corp., Milwaukee. His topic was "The administration of QC in today's industry." His talk covered the basic philosophies and concepts of a successful QC program.

UNIVERSITY OF WESTERN ONTARIO . . . Executive meetings were held on Aug. 13 and 27 at Kitchener to discuss and finalize plans for the 1958-59 program.

On Aug. 20 a meeting was held in Hamilton with the Hamilton and St. Catharines sections to make plans for the forum to be held in Hamilton on Nov. 13. The section accepted the job of leading the publicity committee for this forum.

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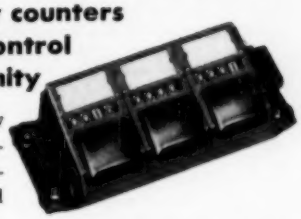

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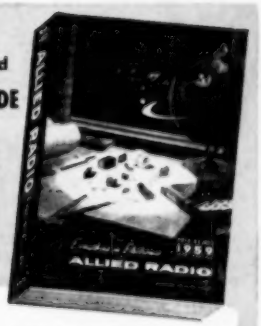

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SIGNIFICANT DIFFERENCES

. . . Allentown-Bethlehem—J. V. Markley, one of our scheduled speakers for the Nov. 12 meeting, has been transferred from inspection supervisor-raw materials inspection to operating supervisor at the Laueraldale plant of Western Electric.

Several section members were speakers at the recent Rutgers conference. Miss Bonnie Small was a member of the panel which discussed "Basic concepts—function of QC." Ken Stevens presented "A multi-level AOQL sampling plan with weighted defect classification." Incidentally, Ken will start his studies at Rutgers this fall for his masters degree in QC.

. . . Boston—Congratulations go to the following members on their recent position changes: Maurice Ahern, quality manager of W. H. Nichols Co., Waltham; George W. Arrants, chief inspector of Baldwin-Lima-Hamilton Corp., Waltham; John W. Beach, QC supervisor, Anderson-Nichols & Co., Boston; Walter F. Bossee, quality engineer, Amperex Electronics, Hicksville, N. Y.; Theodore W. Bussey, director of metrology, W. H. Nichols Co., Waltham; Donald W. Francis, manager of QC, inspection department, General Electric Co., Lynn; Austin A. Fraser, ass't. manager of quality assurance, Missile Systems Div., Raytheon Mfg. Co., Andover; O. H. Somers, QC manager, Semi-conductor Div., Raytheon Mfg. Co., Newton; Howard Whittle, section head, Semi-conductor Div., Raytheon Mfg. Co., Newton; Richard R. Cesati, QC engineer, Medium Steam Turbine Generator and Gear Dept., General Electric Co., Lynn; Louis Rosenblum, superintendent, Matrix Div., Photon, Inc., Cambridge; and Carl Nickerson, instructor at Wentworth Institute, Boston.

. . . Buffalo—Alfred J. Kukla, Jr., a past section chairman, has been transferred to the Chicago plant of the Aluminum Company of America. Al was chief of laboratories at the Buffalo plant.

Fred R. Sheldon, formerly research laboratory manager at Becco Chemical Div., Food Machinery & Chemical Corp., has been transferred to the Princeton, N. J. research laboratory as general manager of the applications section in Food Machinery's inorganic chemicals research and development department.

. . . Chicago—Marvin Claeys has been named quality control superintendent for United Air Lines. This is a newly created positions in which Marv will develop and maintain company-wide programs related to quality control.

. . . Cleveland—Charlie H. Joseph, Jr., has resigned from American Greeting Corp. to become assistant to the president of World Publishing Co. Fortunately, Charlie will remain in Cleveland and continue to lead the section as chairman.

North Electric Co. of Galion has a new director of research. He is Ralph Nottingham who resigned from Clevite Corp. to take this new position. This change has necessitated Ralph's resigning as program chairman. Richard Shaw, Mallory Battery, has been appointed to take Ralph's place.

. . . Cumberland—Recent changes involving senior QC engineers at the Amcelle plant of the Celanese Corp. were: J. S. Sirockman, transferred to cellulose compounds; B. A. Bonebreak, head of textile quality control; P. M. Felker, extrusion quality control; G. W. Duvall, physical testing laboratory; and G. W. Fisk, extrusion development engineer.

. . . Dayton—Section secretary John M. Stanch has been appointed to instruct a basic course in QC techniques which will be given to various members of the Foreman's Club.

. . . Hartford—MacChesney Desmond has transferred from the Hamilton Standard Division of United Aircraft Corp. to Chandler Evans Division of Pratt and Whitney Co. as assistant to the chief inspector.

. . . Indianapolis—Robert Fallows has been promoted to quality coordination manager of the RCA TV Division.

. . . Lima—James Mignin, past membership chairman and sparkplug in section activities, has been promoted to manager of the Toledo office of Marchant Calculator.

Martin Medow, past vice chairman and present chairman of the section, has accepted a position as QC engineer with General Electric Co.

. . . Louisville—All section members wish Dave Charlesworth well in his new position and extend heartfelt thanks for his years of fine work and leadership in the section.

. . . Pittsburgh—Jim Alexander is now with the Texas Instruments Co., Dallas, Texas.

William Martin, Koppers Co., attended the Gordon Research Conference on Statistics in Chemistry and Chemical Engineering. Clark Halloway, Jr., of Gulf Research also attended the conference.

Ed Conty has left Westinghouse Electric Corp. and is no longer in the Pittsburgh area.

. . . St. Louis—Dr. Waldo Vezeau of St. Louis University, ASQC Fellow, recently addressed the St. Louis Chapter of the Society for the Advancement of Management. His subject was "Mathematical statistics and modern practice."

. . . Southern Connecticut—Officers for the 1958-59 season are: chairman—Howard Levenson, Burndy Corp., Norwalk; vice chairman—Howard Burbank, Norden-Ketay Corp., Milford; secretary—Theodore N. Westerman, Dictaphone Corp., Bridgeport; and treasurer—Frank A. Walsh, Dictaphone Corp., Bridgeport.

. . . Syracuse—Robert M. Hofstead, Bristol Laboratories, Inc., took office for the second term as president of the Technical Societies Council of Greater Syracuse. Richard M. Holmes, Carrier Corp., became vice president. Mr. Holmes formerly was council secretary.

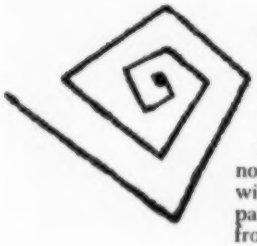
. . . Toledo—Mrs. Rosemary Carroll, who has served the section as a director for the past three years, has been named as a delegate to the Toledo Technical Council and is the first woman ever given that honor. The council is composed of delegates from the 21 technical and engineering societies in the area.

On Aug. 1, Dr. Julian H. Toulouse became a consultant in operations research for Owens-Illinois Glass Co. He was formerly chief quality engineer for the quality and specifications department of O-I's container division. Upon leaving his post he was singularly honored by all Q & S supervisors in the division and by his local department in Toledo. Dr. Toulouse plans to continue an active life in business as a consultant and as a member of ASQC.

. . . Toronto—M. J. O'Callaghan of the British American Oil Co. gave a recent talk to the Guild of Accountants. His topic was "Cost functions derived from regression analysis" which served as a very good example of one of the many administrative applications of QC.

. . . Tulsa—Professor Ashworth of Oklahoma State University has been added as one of our section directors to replace Dr. Hamblen who is moving to the University of Kentucky. Prof. Ashworth is investigating the possibility of starting a student chapter at Oklahoma State University, since they have several students in the statistics field and the computing center.

Thomas Hohn has transferred his membership to our section since his assignment as QC supervisor, Corning Glass Works, Muskogee.



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Practical Aids

ELLIS R. OTT, *Editor*

Rutgers University, 77 Hamilton Street, New Brunswick, N. J.

One-Sided Statistical Tolerance Limits

SIGMUND P. ZOBEL

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In our use of tolerance factors, we found that the Lieberman table failed to provide factors at the $\alpha = 2.5$ percent level, which happened to be just the level we frequently desired. Believing that factors for this level might be generally useful, we submit the following table for $\gamma = 0.90$ and 0.95, and for the same sample sizes provided in the Lieberman table. Construction of this addition to the Lieberman table was made following the computational procedures used by Lieberman.

Editor's Note

The following has been submitted as an Addendum to Table I—Tolerance Factors for Normal Distributions; Lieberman, Gerald, J., "Tables for One-Sided Statistical Tolerance Limits, *Industrial Quality Control*, Vol. XIV, No. 10, April 1958, p. 8.

Tolerance Factors for Normal Distributions

Factors K such that the probability is γ that at least a proportion $1 - \alpha$ of the distribution will be less than $\bar{X} + Ks$ (or greater than $\bar{X} - Ks$), where $\bar{X}$ and s are estimates of the mean and the standard deviation computed from a sample of size n.

$\alpha = 0.025$

n	$\gamma = 0.90$	$\gamma = 0.95$
3	6.243	8.986
4	4.637	6.015
5	3.981	4.908
6	3.620	4.330
7	3.388	3.969
8	3.226	3.723
9	3.106	3.542
10	3.011	3.402
11	2.936	3.291
12	2.872	3.201
13	2.820	3.125
14	2.774	3.060
15	2.735	3.005
16	2.700	2.956
17	2.671	2.913
18	2.643	2.875
19	2.618	2.840
20	2.597	2.809
21	2.575	2.781
22	2.557	2.756
23	2.540	2.732
24	2.525	2.711
25	2.510	2.691
30	2.450	2.608
35	2.406	2.548
40	2.371	2.501
45	2.344	2.463
50	2.320	2.432

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NOMINATIONS FOR THE 1957-1958 BRUMBAUGH AWARD

In accordance with the provisions governing the Brumbaugh Award, nominations by individual members of ASQC are requested in order to assist the Brumbaugh Award Committee in making its selection. Below is a ballot for your use. Please fill in the ballot and *mail it now.*

In making your selection, please keep in mind that you are to choose the article published in *Industrial Quality Control* that you judge to have made the greatest contribution to the development of industrial applications of Quality Control.

Send your ballot to Cuyler J. Hawkes, Eastman Kodak Company, Apparatus and Optical Division, 400 Plymouth Ave. N., Rochester 4, New York. All Ballots received up to Nov. 1, 1958 will be accepted.

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(signed)

The articles which are eligible for this year's award are those that appeared in Volume XIV—July 1957-June 1958.

ASQC Announces

Advancements and New Members

(as of August 24, 1958)

ADVANCEMENTS TO THE GRADE OF SENIOR MEMBER

Anderson, Darrel E., Portland, Ore.
Anton, Charles, Salem, Mass.
Barett, Donald J., Berkeley, Calif.
Berkhimer, Ronald J., Berkeley, Calif.
Brown, DeWitt C., St. Petersburg, Fla.
Brunka, Frederick C., Freeport, Ill.
David, Nasim A., Worcester, Mass.
Doyle, James J., No. Grafton, Mass.
Drumm, Edwin F., San Antonio, Tex.
Eberhard, Walter S., Towanda, Pa.
Fahy, Christopher G., Hollister, Calif.
Ferry, Robert A., Cincinnati, Ohio
Giachino, Marcello T., Memphis, Tenn.
Gilman, James R., Framingham, Mass.
Grant, Nelson B., So. Lancaster, Mass.
Gray, C. Kenneth, Huntingdon Valley, Pa.
Green, Dudley S., Corpus Christi, Tex.
Gregg, Glenn E., Portland, Ore.
Hancock, Donald E., Portland, Ore.
Hudson, Harter G., San Francisco, Calif.
Ivan, Joseph A., Toledo, Ohio
Lane, Charles R., Portland, Ore.
Mark, Richard L., Shrewsbury, Mass.
McCall, Chester H., Jr., Silver Spring, Md.
McNeff, Robert D., Indianapolis, Ind.
Meeker, John R., Toledo, Ohio
Ogden, John E., San Mateo, Calif.
Rogers, Martin W., Malden, Mass.
Roth, George H., Albuquerque, N. M.
Samit, Rene, Wyandott, Mich.
Spradley, Elmer B., Houston, Tex.
Swenson, H. Raymond, Elgin, Ill.
Thornton, Allen L., Albuquerque, N. M.
Vanderzanden, William R., Hillsboro, Ore.
Weisbrod, Robert J., Lytle, Tex.

ADMISSIONS TO THE GRADE OF MEMBER

Abenheimer, Matthew P., Glasgow W. 2. Scotland
Allen, Richard W., San Diego, Calif.
Almazan Posada, Artemio, Mexico City. Mexico
Anderson, Franklin B., Tyler, Texas
Anderson, Gerald F., Clinton, Mass.
Anderson, Marvin C., Mankato, Minn.
Artis, William G., Manitowoc, Wis.
Bailey, George R., La Mesa, Calif.
Bailey, Russell G., Lansdale, Pa.
Barrett, John W., San Diego, Calif.
Beard, Robert L., Kingsport, Tenn.
Bell, Margaret J., St. Petersburg, Fla.
Bellinger, Dwight Q., Woodstock, N. Y.
Benischek, Victor V., Albuquerque, N. M.
Bihun, John, Morgantown, W. Va.
Bird, Kenneth E., Albuquerque, N. M.
Bishop, Wallace J., Tampa, Fla.
Blackwell, Robert E., Ottawa, Ill.
Bren, Thomas R., St. Petersburg, Fla.
Brennan, Thomas F., St. Petersburg, Fla.
Breska, Robert J., Orlando, Fla.
Brierley, Ralph E., Winter Park, Fla.
Briggs, Clark E., Utica, N. Y.
Bright, Kenneth L., St. Petersburg, Fla.
Browne, Phillip W. P., Arvide, Que., Canada
Buck, Warner H., Clearwater, Fla.
Buncic, Louis, St. Petersburg, Fla.
Buss, Edmund E., Albuquerque, N. M.
Capilongo, Dominick, Arlington, Va.
Cara, Orazio D., St. Petersburg, Fla.
Carrell, Samuel L., Dallas, Tex.
Carrick, Paul M., San Diego, Calif.
Cary, George W., Portland, Ore.
Case, Warren A., Largo, Fla.
Chambers, Robert W., Kingsport, Tenn.
Chase, John F., St. Petersburg, Fla.
Ciavola, Philip A., Clinton, Mass.
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Dalton, Maurice G., Tampa, Fla.
Dalton, William H., Bronx, N. Y.
Dantowitz, Allan W., Bronx, N. Y.
De La Cruz, Richard, San Diego, Calif.
Degan, James G., Indianapolis, Ind.
Delaney, Francis H., Wappingers Falls, N. Y.
Demaline, Richard E., Defiance, Ohio
Dexter, Albert M., Jr., Avon, Conn.
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Esposito, Antonio, Cochituate, Mass.
Featherstone, Robert K., St. Petersburg Beach, Fla.
Felter, James R., Albuquerque, N. M.
Fenn, William H., Clearwater, Fla.
Fitch, Noble A., Pinellas Park, Fla.
Fowler, Thomas R., San Diego, Calif.
Fradenburg, Harold L., St. Petersburg, Fla.
Fraley, Kenneth J., Kingsport, Tenn.
French, Louis H., Alexandria, Va.
Fricke, Alfred T., San Diego, Calif.
Gage, William G., Jr., El Cajon, Calif.
Gallahue, Raymond L., Jr., Dallas, Texas
Gani, Mohamed H., Karachi, W. Pakistan
Giddings, Ray C., Oak Grove, Ore.
Going, Clinton F., Jr., Plant City, Fla.
Goldberg, Harold L., St. Petersburg, Fla.
Guberman, Barry A., Toronto, Ont., Canada
Hardin, Joseph D., St. Petersburg, Fla.
Harnsberger, Nancy W., Washington, D. C.
Harris, Harry E., Pacific Palisades, Cal.
Harrison, Daniel P., Arlington, Texas
Hart, Ernestine S., Mobile, Ala.
Harvey, Curtis W., Sarasota, Fla.
Henderson, Jimmy E., Memphis, Tenn.
Henriquez, Theodore A., Tampa, Fla.
Hill, Donald V., San Diego, Calif.
Hill, Paul W., Dallas, Texas
Hilzinger, William K., Baldwinsville, N. Y.
Hockoday, Robert B., Kingsport, Tenn.
Holman, Donald J., Toronto, Ont., Canada
Howland, Arthur S., Toronto, Ont., Canada
Horvath, Margaret R., Pinellas Park, Fla.
Iverson, Melvin J., San Diego, Calif.
James, Delmer W., Ft. Worth, Texas
James, William G., Toronto, Ont., Canada
Johnson, Robert D., San Diego, Calif.
Jordan, Edwin M., Hayward, Calif.
Kalanquin, Ray B., San Diego, Calif.
Kalota, Stanley, Grosse Pte. Park, Mich.
Keyster, Louis W., Aurora, Ill.
King, Kyle W., Kingsport, Tenn.
Levsky, William S., Takoma Park, Md.
Livingston, Carl G., Richardson, Texas
Knoll, Hugh R., Dallas, Texas
Kocsi, William S., St. Petersburg, Fla.
Koehler, Wayne L., Rochester, N. Y.
Kohn, Gerald E., Milford, Mich.
Korkuch, Edward J., Hawthorne, N. J.
Kurtz, Samuel E., Millerstown, Pa.
Kynion, Joseph, Birmingham, Mich.
Lample, G. Chris, Jr., Orlando, Fla.
Landry, Walter J., St. Petersburg, Fla.
Lang, Horace N., Tonawanda, N. Y.
Lewis, Donald G., Albuquerque, N. M.
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Lukach, Vincent J., Allentown, Pa.
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Moore, Thomas O., Largo, Fla.
Morgan, Joseph A., Monaca, Pa.
Murray, Stanley A., Kingsport, Tenn.
Myers, Lester W., Largo, Fla.
Myers, Lewis E., Glendale, Calif.
Neale, Herbert M., Arlington, Va.
Newton, Calvin C., Pinellas Park, Fla.
Nichani, Hari L., Palo Alto, Calif.
Nobel, Henry, St. Petersburg, Fla.
Nowels, Charles E., Lockport, Ill.
Nugent, Ralph G., Richardson, Tex.
Odom, Thomas A., Jr., Johnson City, Tenn.
Olt, Robert L., Wilmington, Del.
Orr, Frederick C., Spring Valley, Calif.
Oswald, George J., Phillipsburg, N. J.
Pattison, Jack C., Portland, Ore.
Pereira, Carlos A., Rio de Janeiro, Brazil
Perrette, Cecil L., Tampa, Fla.

(Concluded on page 38)

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1958 Shewhart Medal Nominations

Nominations are now being received by the Shewhart Medal Committee for consideration with respect to the 1958 Shewhart Medal Award. Previous Medalists are:

L. E. Simon	— 1948	H. G. Romig	— 1953
H. F. Dodge	— 1949	E. G. Olds	— 1954
M. A. Brumbaugh	— 1950	W. E. Deming	— 1955
G. D. Edwards	— 1951	M. E. Wescott	— 1956
E. L. Grant	— 1952	C. C. Craig	— 1957

A letter of notification is being sent to all ASQC Section chairmen. Any member of the Society is privileged to make a nomination for this honor. It is important, however, that any nomination be accompanied by suitable biographical and other information supporting the nomination so that the Committee will be able to give adequate consideration to the qualifications of the nominee.

Nominations should preferably be forwarded to the Shewhart Medal Committee through the Chairman of the local Section, but may be sent direct with supporting information (10 copies, please) to the Chairman of the Medal Committee, Lloyd A. Knowler, Department of Mathematics and Astronomy, State University of Iowa, Iowa City, Iowa. Nominations received by the Medal Committee on or before December 31, 1958, will receive due consideration.

PETERSON, ROBERT J., Palo Alto, Calif.
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Twelfth Annual New England QC Conference

The New England Conference Council, ASQC extends an invitation to you and your personnel to attend the Twelfth Annual New England Quality Control Conference. This year's conference will be held in at the Wendell Sherwood Hotel, Pittsfield, Mass. on Oct. 30-31.

The program for this Conference has been developed to encompass a wide range of interests:

Seminars guided by top industrial consultants;
Technical sessions presented by outstanding speakers;
Education program taught by practicing quality control engineers.

These features combine to provide comprehensive coverage of the entire quality control field.

The *seminars* have proved to be one of the most popular features of the conference. Continued participation, by management personnel from leading New England industrial concerns, indicates the value of these sessions. The discussion of *quality control* administration has proved advantageous to all those attending.

Thirty-two *technical sessions* will be offered during the conference. This well-rounded program will interest the engineer, supervisor and inspector. Theory and practice have been combined to maximize lecture value. Don't miss this opportunity to up-date your *quality control techniques.*

A *coordinated education program* permits a comprehensive introduction to the *techniques and theory of quality control.* Based on the Iowa State University Training Manual, process control techniques and sampling procedures will be taught. Participants will leave the conference with the basic quality control techniques for process improvement.
For details regarding this conference, please contact:

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NOVEMBER

. . . ***6-7—13th Midwest Quality Control Conference, Hotel Muehlebach, Kansas City, Mo., sponsored by ASQC, contact Publicity Chairman, Jay R. Rumberger, Westinghouse Electric Corp., 2208 E. 72nd St., Kansas City, Mo.***

. . . **10-14**—Third Annual Paperwork Simplification Conference, University of Dayton, Dayton, Ohio, contact University of Dayton, 300 College Park Ave., Dayton 9, Ohio.

. . . ***17-18—Sixth Annual Conference of the Aircraft and Missiles Division, Biltmore Hotel, Dayton, Ohio, sponsored by ASQC, contact R. B. Van Lehn, Vernay Laboratories, Yellow Springs, Ohio.***

. . . **17-21**—ARS Annual Meeting, Hotel Statler-Hilton, New York City, sponsored by American Rocket Society, contact Dean E. Roberts, Director of Public Relations, American Rocket Society, 500 Fifth Ave., New York 36, N. Y.

. . . **18-20**—"Standardization—What's in it for me?", Ninth National Conference on Standards, Hotel Roosevelt, New York City, sponsored by ASA, contact K. G. Elsworth, Public Relations, American Standards Association, 70 East 45 Street, New York 17, N. Y.

. . . **30-Dec. 5**—ASME Annual Meeting, Hotels Statler-Hilton and Sheraton McAlpin, New York City, sponsored by American Society of Mechanical Engineers, contact L. S. Dennegar, Director of Public Relations, American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.

DECEMBER

. . . **29-30**—Section M (Engineering) of 125th Annual Meeting of AAAS, Washington Statler Hotel, Washington, D. C., sponsored by American Association for the Advancement of Science, contact Secretary, Section M (Engineering), AAAS, c/o Engineers Joint Council, 29 West 39th St., New York 18, N. Y.

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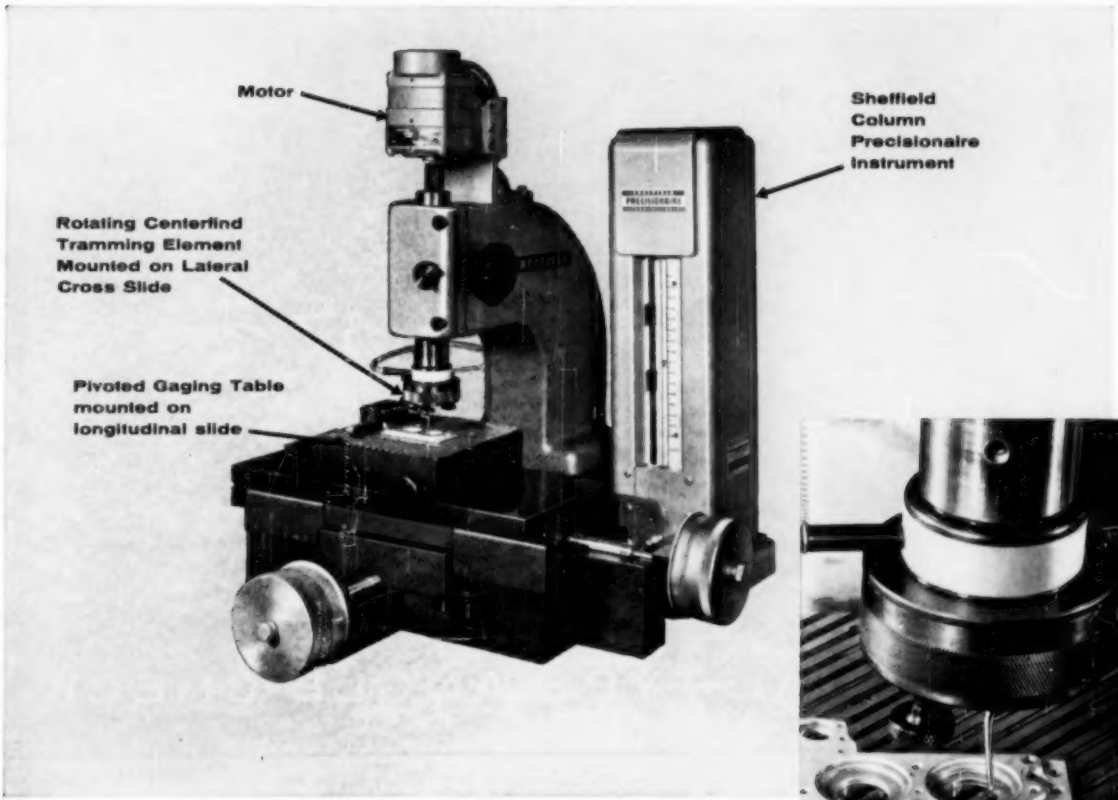
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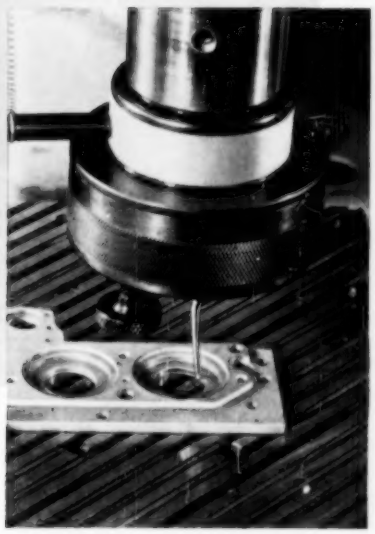

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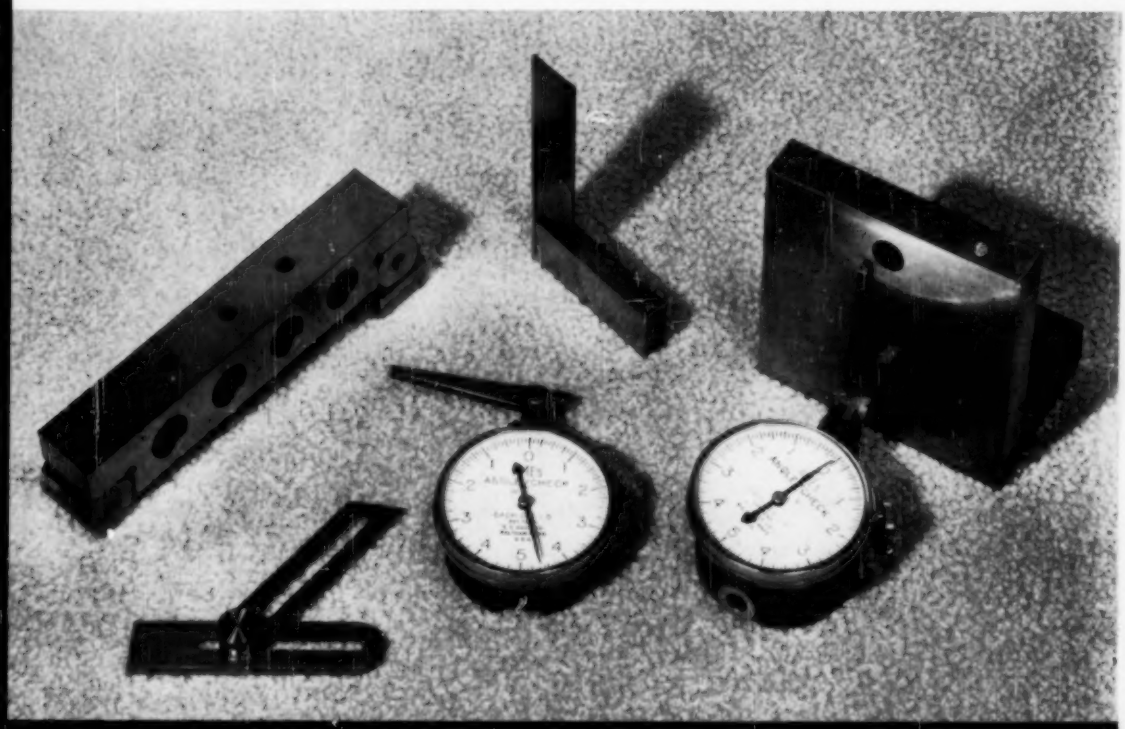

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